# C-Geo USER MANUAL

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# Part

I

# 1    INTRODUCTION

## 1.1    Installation, system and hardware requirements

C-Geo program works under Windows operating system (95, 98, NT, 2000, Millenium, XP).
Minimum hardware requirements: Pentium Celeron processor, 128 Mb RAM, 30Mb hard drive free
space,  SVGA graphic card, mouse. With any better configuration the program will work faster and
more efficiently.

In order to install C-Geo follow the instructions:
1. Insert the installation CD to your CD-ROM
2. Installation wizard window will be displayed automatically, follow the instructions on the screen.
3. If the installation wizard doesn't show up automatically open Windows Explorer -> CD-ROM drive ->
and start SETUP.EXE file. Follow the instructions on the screen.
4. When "Borland Database Engine Installation/Upgrade" window will be displayed press OK - this
program is necessary for proper functioning.
5. When the installation is completed press the FINISH button, C-Geo program will open
automatically.

## 1.2    First start-up

When C-Geo program starts a login window shows up. It is not necessary to login if there is only one
user of the program, in this case just press OK. You may stop displaying the login window in the
program's configuration.

If there is more then one user of C-Geo the login window enables to register  information such as who
created a project.
ATTENTION -  after first installation of C-Geo only one user (administrator) is defined with **blank
password.**
In order to change the settings click the CHANGES  button, this window will be displayed:

Here you may change passwords or add a new user.
After starting the program information about the owner of the license is displayed in the lower right
corner.
To start a new project go to upper menu FILE->PROJECTS.

## 1.3    Basic definitions

**Project**  -  group of tables and maps.
**Work table**  -  set where points coordinates are saved. Tables are saved in Paradox format.
**Object**  -  basic element of the map drawing (e.g. parcel, building, lamp-post).
**Map**   -  image generated by the application on the basis of  data from the tables. Map can not exist
without the chart it refers to.
**Layer**  -  group of elements of one kind.
**Regular table**  -  one of the tables (not necessarily from the project) from which the coordinates of
each point are taken.
**Data set** -   contains descriptions of objects from one layer.

## 1.4 How to work with C-Geo

**Simplified description of work stages in C-Geo program:**

1. Create a project
2. Create a table of coordinates
3. Enter (import) points coordinates
4. Geodetic calculations
5. Print calculation reports
6. Generate a map (optionally import a map or load a raster)
7. Create objects
8. Map drafting
9. Map export or printout

### 1.4.1 Create projects and tables

In order to start working with the program create a new project by clicking on the option PROJECTS->Add new project (Projects may be grouped in folders). Enter project name and press OK. The next step is to create a table in the project, you may also choose a table template. Enter table name and press OK. While creating a new project you may specify its projection parameters, enter accuracy data and angular units used for calculations.
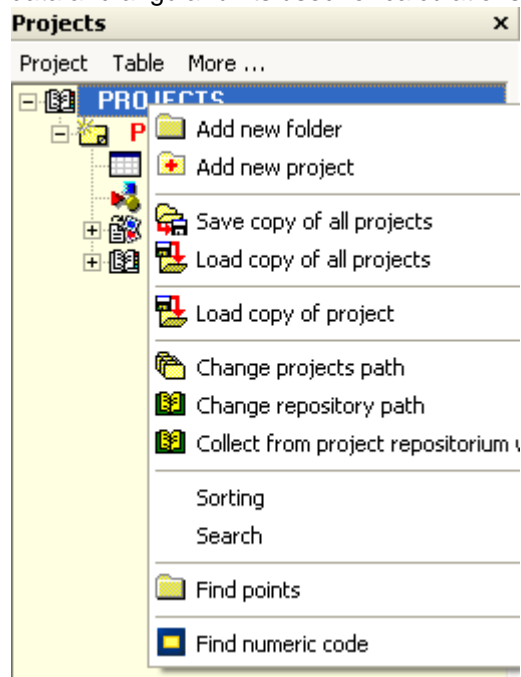


There are three kinds of tables: regular, work and primary. All tables consist of a set of coordinates and a map. The table you have just created is the regular type. You may create many tables in one project. To work with a specific table change it into the work type (right-click on created table and choose "Set as work table") - only then calculated coordinates will be saved in this table. Only one work table can be created in the project.
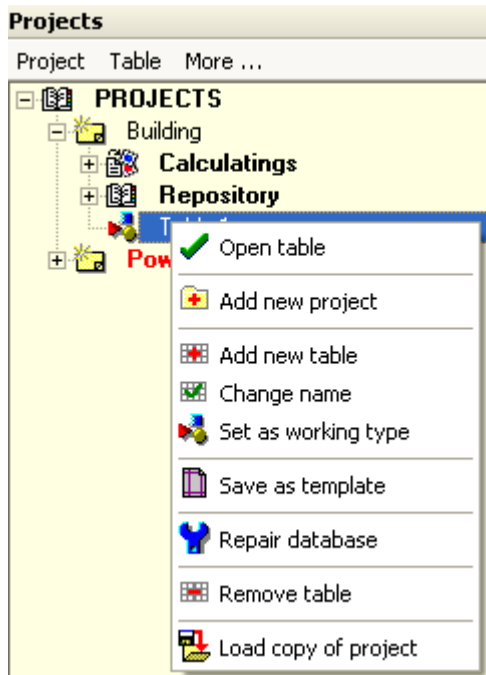
The choice of the table needs to be done when we require data from another table. E.g. we have two tables named 1 and 2. Table 1 is set as the primary one. Table 2 is set as the work one. We work on the second one and there new coordinates from calculation modules will be written.  When entering a coordinate in the module the program will search for it in the work table (table no. 2 ) if it is not there the program will search the primary table. Generally C-Geo takes coordinates for calculations from primary tables and saves them in the work table. The choice of the primary table is done by clicking  "set as primary".
In the project menu it is possible to search for a project according to certain parameters (e.g.: name, cadastral unit, work book no., etc.) or according to given description of the object area.


**Save a backup copy.**
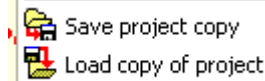
**- w**hen you choose the location to save your projects (default path is C:\C-geo6\projects) you may also create a backup copy of all projects. If you want to use a 1.44Mb floppy disk saving wizard will ask you to insert another disks until all projects are saved. If you want to use a CD we recommend  to compress files first (ZIP format is available in the program). If you decide to save files on a CD without any compression please keep in mind  that all files will have "read only" status which has to be changed manually after copying the files back on your hard drive.

**Load a backup copy**
You may load a backup copy of one specific project or  all projects.
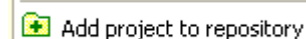
- right-click on your project and choose "Add project to repository". Added project will be available for other users in the local network. It may also be considered as a backup copy solution.

- set "repository" and "projects" paths: click on

"Projects" then right-click.
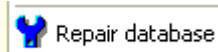
- repairs damaged index files in  the selected project or table. Use this function when the database error information shows up. Before you start repairing the database close C-Geo program and restart your computer. Open C-Geo program again go to FILE->Projects and select the project/table you want to repair, click on "Repair database" button.
We strongly recommend creating a backup copy before repairing the database. If the database repair function doesn't help please send us your damaged project via e-mail..

 - is used to change the name of the tables. Change of projects names can be done using the windows explorer.

### 1.4.2   Additional descriptions

In the project menu window click  "More" to see an extended view with descriptions such as: name, cadastral unit, work book number etc. Here  it is also possible to add an additional description.

# 1.5    Import

Some data can be imported only from the table level whilst other data can be imported only from the map level (e.g. AutoCad dfx file can be imported from map level only, text file can be imported only to a table)

## 1.5.1    Geo-Info

- Geo-info – importing batch files accepted by the Geo-info program. Depending on set options "OPTIONS -> Map -> Set of codes" transmission from Geo-Info ver. 2.0, 2.6 or 2000 is active when the table window is active. Only files containing sets of coordinates will be imported. Import of the rest of the data is available after setting the map window as active.

To load batch files of the Geo-Info program:
- open table window,
- choose option: "File -. Import -> Geo-Info",
- find the batch file on the disc,
- after loading the data open the map window,
- using the option "Map -> Layers" define the layers or set attributes on the existing layers: "parcels", "usable lands", "buildings" depending on    what type of data is being imported,
- set option "File -> Import -> Geo-Info", find the batch files and select one, some or all of them, if among those files is a file with "other"
  extension than before importing a dialog window will appear asking into which layer should it be imported.

## 1.5.2    AutoCad (*.dxf)

- dxf – format of the AutoCad application – this option is available only when the map window is active.

To load DFX file format:
- start a new project or open an existing one
- create new teble of coordinates. Open the map without entering the coordinates.
- select option "File -> Import -> Auto CAD DFX", find the desired dfx file and load it.

- use  button to enlarge the image to fit the screen.

## 1.5.3    Microstation (*.dgn)

- dng – Microstation – this option is available only in the map window. It applies only to dng files from ver 7.

## 1.5.4    Map Info 3.0

- map info 3.0 – importing the mif files created by the Map Info program. Option available only when the map window is active.

## 1.5.5    EWMapa

- EWMapa – importing ASCII files created by the EWMapa program. Before importing select the layer where the data will be imported. The ASCII files must contain data exported from the EWMapa program by using the option: "Transfer data -> copy points into ASCII format", however it should not contain coordinates of the points numbers. Another type of data transferred from EWMapa are parcels. Parcels are exported from EWMapa by using the option "Transfer data -> Copy parcels into

ACSII format". Both points with coordinates or bend points numbers can be used as bend points. The third structure derived from EWMapa are borders of the usable lands. In this case one should use the "Parameters" tab in order to load and recode table containing land data.

## 1.5.6 Text file

- Import coordinates data saved in a txt file.
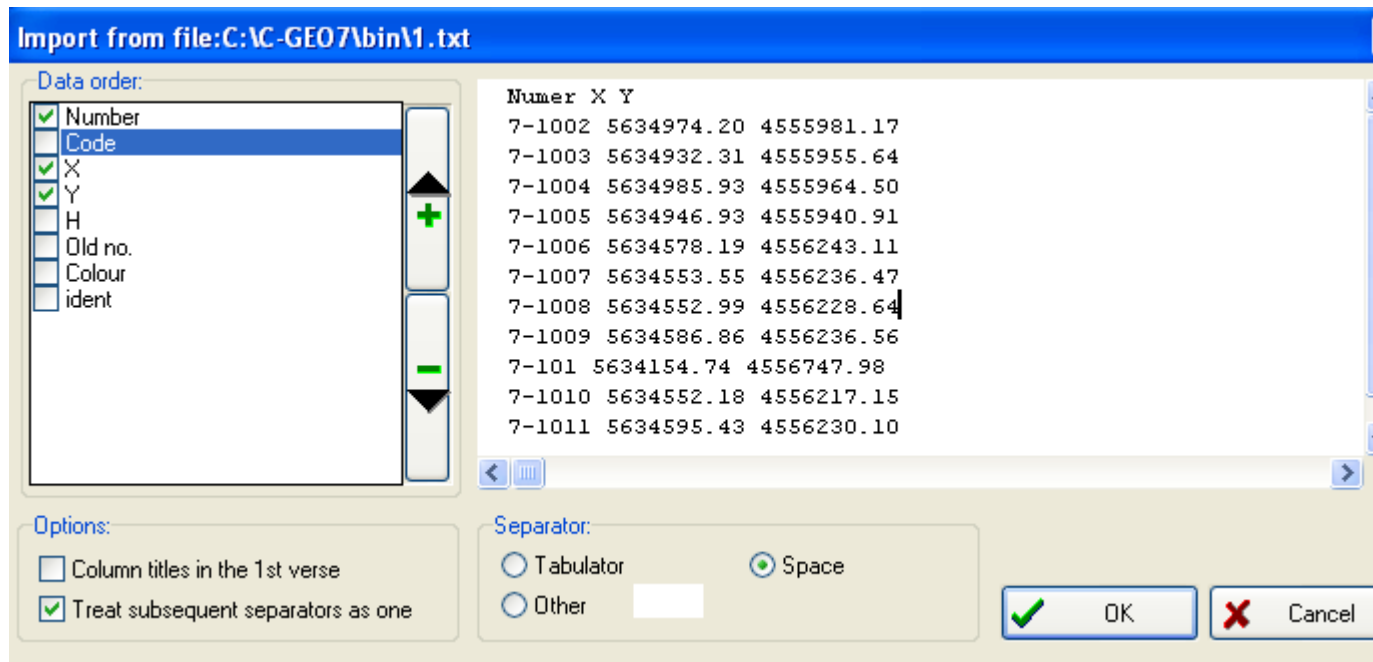


First choose a txt file to be imported then specify:

- data order - columns arrangement in the txt file (buttons  ),
- separator - symbol which separates each value in one row,

Selection field "Treat subsequent as one" enables proper data import when some values are separated with more than one separating symbol.
A preview of the txt file is displayed in lower part of the Import Window.

## 1.5.7 Leica GSI

- Import data from Leica - find GSI file format.

## 1.5.8 Tango

- TANGO - import graphics and database of attributes from TANGO format.

## 1.5.9 SHP

- SHP - import ArcInfo program file format with objects location and attributes database. First import layers containing boundary points then objects which will attach to the boundary points.

## 1.5.10  Garmin

- Import tracks from text file in GPS Garmin format.

# 1.6  Export

Some data can be exported only from the table level whilst other data can be exported only from the map level (e.g. AutoCad dfx file can be exported from the map level only, text file can be exported only from the tables).

## 1.6.1  Geo-Info 2.0

- Geo-Info - save batch files for Geo-Info program. Before performing the export operation set in the program parameters the type of codes for Geo-Info 2.0. In the dialogue window all layers from the map are shown. Cross mark in the first column indicates that this layer will be exported. In order to exclude a layer from exporting highlight layer's row and press <F5> or remove the X mark form fist column. In the third column you may enter a code which will be assigned to all objects without a code. Fourth column shows  names of the batch files. If there are data sets created for specific layers you may export them, choose what fields should be exported and under what name. In the "Export range" tab set  if all objects will be exported or the map window content only or objects selected in the database (e.g. by SQL query).

## 1.6.2    Autocad

- dxf – format of the AutoCad application – this option is available only when the map window is visible. Mark in the first column indicates that this layer will be exported. In order to exclude a layer from exporting highlight its row and press <F5>  or remove the X mark from the first column. In the third column enter the name of line type in AutoCAD which refers to the line type in the exported layer (if the user of AutoCAD has not defined proper - geodetic - types of lines they will appear as solid lines). In the "Export range" tab set  if all objects will be exported or the map window content only or objects selected in the database (e.g. by SQL query). Contour lines may be exported to DXF format with the heights of skeleton points - it makes it easier to picture a 3D map drawing in the CAD programs.

## 1.6.3    Map Info 3.0

- Map Info 3.0 - export files to MIF format accepted by Map Info program

## 1.6.4    Microstation

- Microstation – exporting data in the microstation program format – DNG files or text script files (they can be loaded into microstation using the following option: "Utilities ->Key in", entering command like: @c:\cgeo\eksport\map.scr, pay attention that there is no space after @). This option is active only in the map window. All the layers on the map are displayed in the dialog window. Mark in the first column indicates that it will be exported.

In order to exclude one of the layers from being exported select it and than press <F5> or simply click in the first column and select the proper option from the context menu. In the third column the color of the C-Geo layer is entered.

In the "Export Area" frame user can set whether all or only some selected elements of the map or table will be exported.

Additional parameters of the exported data can be found in the Parameters tab:

- line style in C-Geo – type of lines used by microstation. Number of the line in C-geo must be

  entered (starting from number one, according to order of line types in the Layers option  of the map),
- line thickness – thickness of the line in microstation,
- symbols in C-Geo – "cell" in microstation. C-geo point codes are listed there and the proper names of the cells defined in the microstation must be given. This will convert C-Geo symbols into microstation symbols,
- additionally export of not-coded points or symbols can be disabled, or all symbols can be exported as vectors,
- it is possible to set the size of not-coded points and setting the size of font used by microstation and also setting the origin point of the coordinate system (global origin) of microstation,

Attention! A list of symbols and lines of Microstation is provided with CGeo. It is located in the CGEO\BIN directory – the directory is named WSMOD. If it is copied to the directory, where Microstation was installed, the maps exported from C-Geo will be loaded into Microstation according to the K-1 instruction (symbols, types of line).

### 1.6.5    EWMapa

- EWMapa – ASCII files for the EWMapa program

In the dialog window  all the layers available on the map are displayed. A mark in the first column indicates that this layer will be exported.

In order to exclude one of the layers from being exported select it and than press <F5> or simply click in the first column and select the proper option from the context menu. In the third column enter the name of the text file containing exported data about points or objects.  Furthermore, additional constant information about the points can be entered: type of point and stability. In the "Export Range" frame user can set whether all or only some selected objects will be exported.

### 1.6.6    Metafile (*.wmf)

- wmf - files contain graphics in Windows Metafile format. This export enables to transfer drawings  to different Windows applications  e.g. MS Word, Excel or Corel Draw  and then to merge them with other elements like tables, reports, forms.

### 1.6.7    SWING

- SWING - export graphics and description base to SWING format (K1)

### 1.6.8    Text file

- Export coordinates to a text file.

Select in the check boxes which fields you want to export. ,  buttons allow to change columns order in the text file.

In the frame "Separator" choose "Separator" - a symbol which will separate each value from another.

### 1.6.9   To other map

This option enables to combine or double maps. Indicate export range and select which layers are to be exported then choose the project and the table where selected data should be exported.

### 1.6.10   Leica GSI

- Created file can be loaded to Leica Survey Office for tacheometric survey.

### 1.6.11   Cartometer

- Cartometer - export selected points from the table to "xy" or "xyh" formats acceptable by cartometer's software.

### 1.6.12   Tango

- TANGO - export graphics and database of attributes to TANGO format.

### 1.6.13   SHP

- SHP - export objects location and attributes database to ArcInfo program format.

### 1.6.14   InRoads

- InRoads - export all linear objects, surface objects and points from selected layers to InRoads format.

### 1.6.15   Map export to a raster file

Export  vector maps to a raster file. Select  file format, color and resolution. If you choose "tiff" format specify its compression and if to create a TFW file - necessary for data import to AutoCad and Microstation. Specify export range (default range is set to current map view). If you want to save particular section enter its name and click on "Mark out from emblem". In the bottom part of the window information about raster size will be displayed. Saving  large raster sizes may take a longer

time.

This exporting method might have many uses. For example some rasters can be combined and form one, or a vector map can be saved as a raster file. What is more such image may serve as a background for another project.

# Part II

# 2    TABLE

## 2.1    Entering points coordinates

There are three ways to enter coordinates of points:

1. By entering data in this order: number, code (if necessary) and XYH points coordinates
2. By importing data from a recorder
3. By importing data from a file (e.g. txt file)

Press <space> key to edit entered values.

## 2.2    Table icons

**During the edition the following methods of points selection are available:**

- **single point** - press <F5> key
- **group of adjacent points** - use mouse to select points ( keep left mouse button pressed and move the mouse in required directions)
- **all points** - by clicking on  icon
- **unselect all** - 
- **inverse selection** - 

Icons : , ,  can be used to:
- **remove** selected points from the table
- **copy** selected points to the clipboard
- **insert** points from the clipboard

 - **choose SQL**. Advanced selection of points. Mainly it is used to search through additional fields added by the user in the table. The "parameters" tab defines if only the beginning, the middle or the ending part of the number must be entered.

 - points transmission from or to a recorder- in the opened window choose transmission direction and the recorder (instrument) type. Click "Start transmission" button.

 - create a list of coordinates in the form of a report, to be printed later. (option of the main menu – REPORTS). There is an option of printing a report with two columns. Forms templates should be saved in the ...BINWSP2 folder.

 - print list of coordinates. You may specify if all points or only selected points will be printed, as well as which data columns (no, x, y, z, code etc...). The report edit window will be displayed before printing. Created report will not be saved in the "Reports" storage.

- 3D model - generate a 3D model of selected points. This simple function shows a 3D view of points coordinates from the table.

- documents for points - attach a document to a point. Choose a point from the list then click "Add" or "Scan" a document (or documents).

## 2.3    Map preview

- click this icon to activate the map preview window. Place mouse cursor on any point in the table

to see its location on the map. Use 🟦 🟦 icons to zoom in and zoom out.

- go to the map window

- close the table window

- modify table structure. This option enables to add/remove new columns in the table. Enter column name (letters only) and column type. Use  cursor to add new rows.

## 2.4    Tabs in opened windows

Tabs of the opened maps, tables and C-Geo calculation modules are placed under the map and the table. They can be enabled or disabled in the "options- toolbars".

## 2.5    "Color" column

Double-click on the color to choose symbol color for point (if it exists).

**Example:**
Name: *Stabilization* Type: *complete*. After clicking the OK button a column named "stabilization" will be added to the table, where integers can be entered. If you want to remove one column, click its name and push the DEL button.

## 2.6    Context menu

**Context menu** (available by clicking the right mouse button) in the "Table" window contains options as follows:
- **Select** - F5 - selects points in the row indicated by the cursor
- **Invert selection**
- **Undo remove** - Crtl+Z - reverts point deleted by Crtl+K command (delete line)
- **Delete line** - Crtl+K - removes row of data where the cursor is placed
- **Delete selection** - Crtl+Del - deletes selected points
- **Find point** - Crtl+S - search for point number
- **Open map** - shows the map view based upon table coordinates
- **Change points code** - Crtl+P - change or enter a code for selected points
- **List of codes -** opened code window is linked with the table, it allows to assign codes to this table (

button or <Crtl+P>)

- **Recent codes** -a list of recently entered codes
- **Create tacheometric task** - it enables to generate tasks for the tacheometry module. Select points in the table then create a new task.  Set the station, tie point, height of the instrument, mirror and angle accuracy. After proceeding to the tacheometry module load saved task.
- **Copy content of this column to other** - if there are additional columns in the table you may copy columns content between the columns. Select points to be copied and indicate the target column.
- **Change color of selected points -** change color of  symbols assigned to points

## 2.7     Sorting

- choose sorting criteria: number, code, X, Y, H. When "None" option is selected points will be sorted by the date of insertion to the table.
- it is possible to sort selected points only.

## 2.8     Select points

- **From item to item** - select points with certain ordinal numbers
- **Number -** select points with given numbers
- **Number - pattern**

Special characters used in the pattern:
? – random character
* - random string
[…] – random character from among …
[-…] – any character different than …
[a-z] – any character from a to z
[-0-9] – any character different from the range in brackets
{…} – groups fragment of a pattern, it allows it to be treated as a single character
| - the next or pervious character
& - random number of repetitions of the pervious character
\ - deletion of the next special character
Example: pattern [0-9]&|{[A-Za-z][0-9]-[0-9]&}- selects numbers: 10, 12, aa1-15, c3-40 etc.

- **Nearby** – select points that lay in certain distance from the point where the cursor is placed.
- **Area** – select points laying in an area restricted by borders drawn by certain points

## 2.9     Find point

- Depending on the column where the cursor is placed you may search for points by: number, code x, y, h or different columns.

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## 2.10    Remove point



- Remove point with given number

## 2.11    Renumber points

Change numbers of points selected in the table. Enter data as follows
- new number of the first point
- value by which the number of the next point will be increased
- optional prefix – string of characters placed at the beginning of the number
- optional suffix - string of characters placed at the end of the number
- renumber points downwards – 5,4,3,2 …

## 2.12    Change of points code
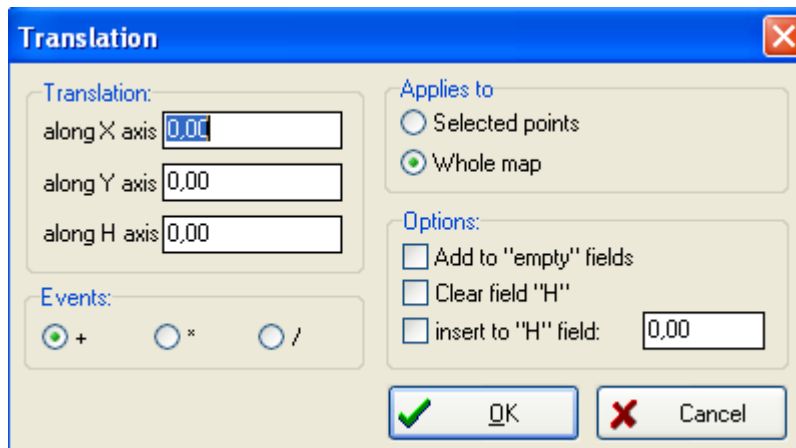
- Set a new code (entered by the user) for selected points. If  no code is entered and  the OK button is pressed the existing codes will be removed.

## 2.13    Translation

**Shift selected points by given values.**
Enter shift values for particular axes of the system of coordinates. If a map was already created for the table then  set "whole map" value in the "Applies to" option.
This setting will shift all objects (inscriptions, linear objects, symbols etc.). You may also choose the translation type: parallel shift ( <+> symbol),
use a coefficient to increase the coordinates along X or Y or H axis (<*> symbol), use a coefficient to reduce the coordinates along X or Y or H axis (</> symbol>.
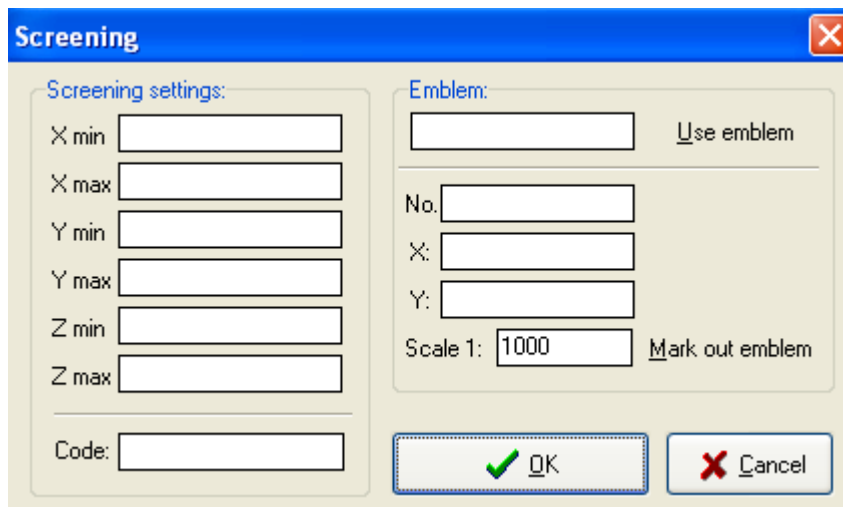
- Add to "blank" fields - check this option to also translate blank fields
- Clean H column - will delete all content of the H column
- Insert to H field - inserts entered number to the H field

## 2.14   Rectangle screening

This function selects points within given criteria. Enter minimum and maximum coordinates values to determine the rectangle area of search. Blank field means that this criterion will not be taken under consideration (e.g. no H min. value when H max. value is set to 100.00 will select all points with H lower than 100.00).

Setting the min. and max. values of the X and Y coordinates can be done using the map emblem. If the emblem is known enter its value in  the "emblem" frame and then press the "Use emblem" button. If it isn't known, but you know the coordinates (or the number) of the point laying on the map sheet you are interested in as well as the scale of this map, you can calculate the emblem from the map. To do so enter the data in the proper fields and press the "Mark out from emblem" button.

Use "Code" field to enter  code of points as an additional screening criterion. This will select all points with given code.

## 2.15   Statistics

Information about: the number of points in the table, max and min coordinates, number of inscriptions, number of objects on the map and the area covered by the map.

## 2.16   Restore previous number

If a point number was changed in the edition mode or as an effect of the "Renumber points" function its previous number is still saved in the "Old number" column. Choosing the "Restore previous number" option will switch values between the "Old number" column and the "Number" column. This option works with selected points only.

## 2.17   What to edit?

- Select editable columns. Values in not editable columns will appear in gray.

## 2.18   Points control

When working with the tables the "Points control" function is available. You may control points with this same number or located nearby (user sets the control range). A list of points within selected search criteria will be generated as a result of using this function. You may then remove duplicated points or nearby points.

## 2.19   Points transmission

- **Points transmission to field recorders** enables to transfer selected points to:
Psion WorkAbout
Psion XP, LZ (M-Geo)
Elta 50R
Topcon GTS
Sokkia Set 5F – to a file
Sokkia Set 5F
Sokkia Set 500, 600, PowerSet
Elta R
Elta C
Zeiss DiNi
Nikon DTM 300
Nikon DTM 330, 350, 500, 501, npl350
Geodimetr file format
Topcon SSS
TerMap
Leica GSI (8-digits format)
Leica GSI (16-digits format)
South

- **Points transmission from field recorders** enables to transfer selected points from:
Psion WorkAbout
Psion XP, LZ (M-Geo)
Geodimetr
Topcon GTS
Topcon SSS
TerMap
Nikon DTM 330, 350, 500, 501, npl350
Pentax

South

Choose transmission type then press "Start transmission" button and follow the instructions in the transmission window.

## 2.20 Show hidden points

If there are any points without numbers on the map activate this option to see them in the table with the @ symbol. Points without numbers usually appear when an object is being drawn on the map and the "Snap" function is turned off. You may also uncover previously hidden points with numbers.
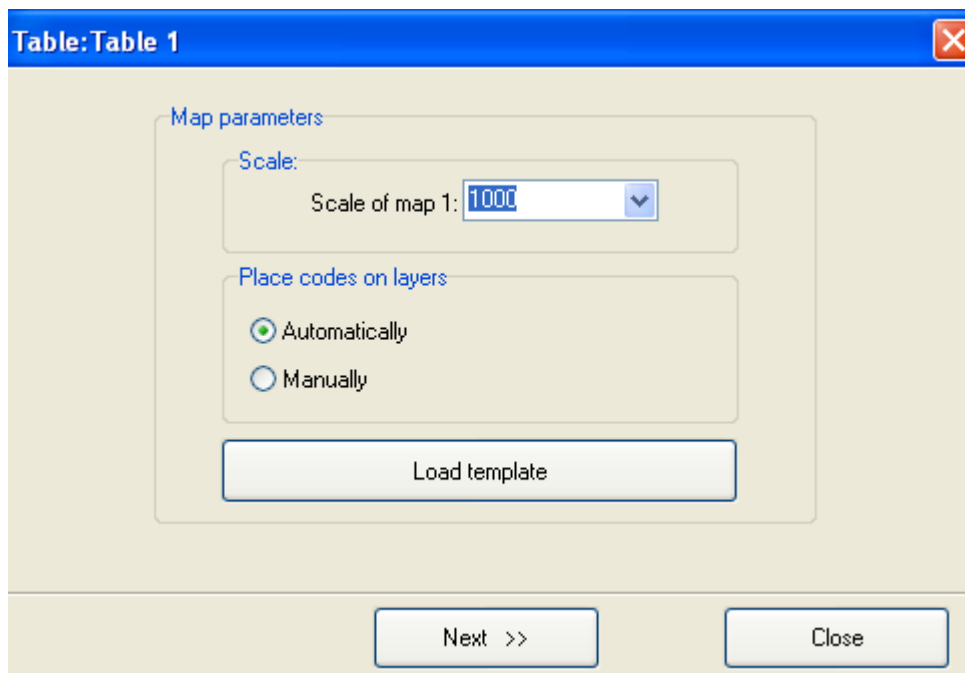
## 2.21 Hide selected points

Points in the table may be hidden. Before using this option use the mouse or the F5 key to select points you want to hide.

## 2.22 Hide @ points

Only points without numbers will be hidden (these points were previously displayed by activating the option "Show hidden points")

## 2.23 Map creation



The map is created automatically by the application, however the user can re-draw the map manually. Delamination of layers is based on the codes of the points. User is than free to group the codes on each layer. Points that are not coded are placed on a special "zero list". It is not necessary to enter values of each point to the table. Coding the points can be done directly on the map by clicking each point. Each table can have one map directly associated with it. Each change to the points in the table will immediately change the image of the map. Map generation process begins after selecting the following option: "Table -> Crate map". If a map associated with the current table already exists, than selecting this option will destroy all the content of the map (structure of objects). This is why usually map is drawn only once for each table. After selecting the "Create map" option the program creates map's sets. Then the scale of the map needs to be set (it can be changed later) and the method of

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placing codes on the map needs to be selected.

Use "Load template" button to load a previously saved template. Saved templates contain information as follows:
- layers - names, layer parameters
- codes assignment to layers
- data sets structure in layers

If you load a template it is no longer necessary to create layers, set layers attributes and to create data set structures.

Move to next step by clicking on "Next >>" button

There are 2 ways to assign codes to layers:

1. Automatically - for each code in the table a layer will be created (with this same name as code name)
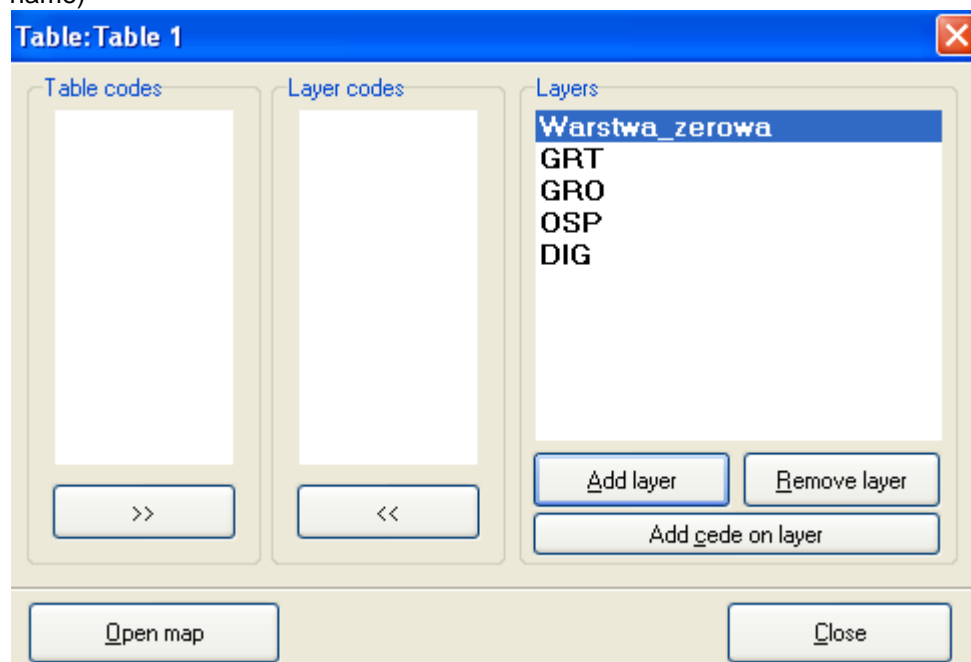


The picture above shows the effect of automatic codes assignment to layers. In this exemplary table points with GRT, GRO, OSP, DIG codes are shown. For each code a separate layer was created. Additionally a "zero layer" was created for the points that have no code at al

2. Manually - user creates layers and assigns codes to layers. First list shows all codes found in the table. Second list contains codes assigned to selected layer. To assign a code click on ">>" button. Example: by pressing ">>" button in a situation as shown on the picture the GRT code would be assigned to "Layer zero". "<<" button enables to remove codes from the layer.

Third list "Layers" contains names of available layers.
You may add/remove layers by using "Add layer" and "Remove layer" button. See also Codes-Layers.
Click "Close" or "Open map" button.

# Part

**III**
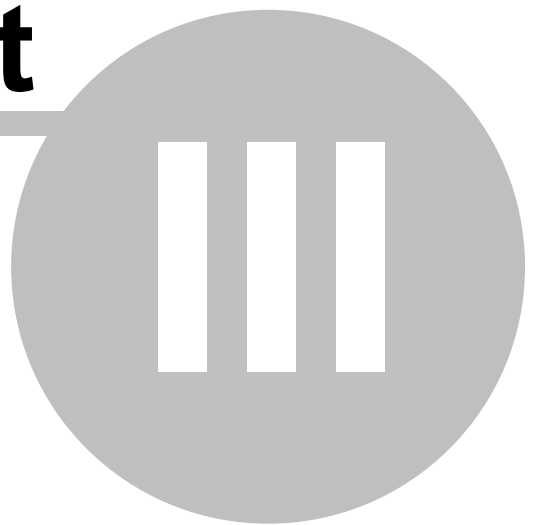
# 3 MAP

## 3.1 General description

Several functions are available to simplify edition of the map:
Moveing the map in the window:
- cursors - shift the map in preferable direction. Additional options:
  - hold <Alt> key to decrease shift
  - hold <shift> key to increase shift x2
  - hold <Shift + Crtl> to increase shift x4
- numerical keys 1,3,7,9 (on a numerical keyboard with NumLock function turned on) move the map in oblique directions (north-west, north-east etc.)
- hold <Shift> key (mouse cursor will change to a "hand cursor") press and hold left mouse button then move the mouse  - will move the whole map in any direction

On a numerical keyboard press <+> to zoom in and <-> to zoom out the map centrally where mouse cursor is located.
All functions mentioned above are also available in the object drawing mode.

## 3.2 Objects and objects drawing

As objects C-Geo program classifies: closed lines, open lines, arches, circles, symbols, texts. Objects are drawn by selecting the appropriate tool and clicking the point which will mark the position of an object. There is an option that will allow placing objects only when they are associated with an existing point – the "attach without points" option is enabled. The snapping range of the points can be set by the user (in millimeters).

Several help keys are available while drawing an object:
- **cursors** - shift map  without stopping to draw. This option enables to draw an object even when some of its points are not visible on the screen view.
- **<+> , <->** - zoom in and zoom out your drawing
- **<Page Down>, <Page Up>** - edit previous (next) side of drawn object. Use this option to move back to previous sides if for example you forgot to add  one or more points. Move forward to the last drawn side by pressing <End> key.
- **<Backspace>** - delete last drawn bend  point on the object
- **<Esc>** - stop drawing (object will not be saved)

**Context menu** (available by clicking the right mouse button) contains options as follows:
- **finish** - finishes object drawing. If you draw a closed object this option will "close" the object automatically.
- **finish  perpendiculary** - option available for closed objects only - will close an object by adding straight lines perpendicular to first and last drawn sides.   If the drawn object was based upon existing points, than after selecting this option a dialog window will appear, where user can enter the number of the new point (laying on the intersection of two perpendicular lines).
- **close toward frontages** – closes the drawn object by adding straight lines at given length.
- **draw perpendicular** - draws perpendicular lines only.
- **next point** – this option enables adding a new point at the end of a segment. After selecting this option user must choose whether the point will be placed on the lengthening of the line or at a desired angle to the line (left or right). A dialogue window will appear, where the number and the code of the new point can be entered, and parameters needed to calculate the point's position, like: line length, direction and angle. Adding a new point is finished by clicking the OK button. This option especially allows for mapping objects from the frontages.

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## 3.3    Creation of parcels and usable land objects

**Parcels (usable lands) may be added in two ways:**

1. Textually - enter points numbers and boundary points coordinates. Use the Editor of objects or parcel area calculation. If you want to edit an object first set the parcel (usable land) layer as editable.
2. Graphically - use the mouse cursor to connect the points. To draw objects boundaries use the

closed object tool (  icon) or the polyline tool (  icon). The polyline tool enables to draw boundaries without closing the parcels into closed objects. A polyline may be divided  into its component  - segments. Several options are available when drawing a polyline:

- **<Backspace>** - removes last connection point
- **<PgDown>, <PgUp>** - inserts (adds) a bend point on a previous (next) broken line segment
- **<End>** - use this key after using <PageDown> key to move back to the end of drawn broken line
- **<+>** - zoom in the map view
- **<->** - zoom out the map view
- **numerical keyboard, cursors -** move the map view
- **hold <Shift> key (mouse cursor will change to a "hand cursor") press and hold left mouse button then move the mouse**  - will move the whole map in any direction

When all boundary segments are drawn use the option "Create objects" to create objects automatically (parcels -usable lands- will be created as closed objects). When performing this option the program will check intersections between segments and inaccuracy around boundary points. If any problem is found an error message will be displayed.

The option of calculating parcels (usable lands) area is strictly connected with the map therefore it is only active when the map is created. Entered parcels (usable lands) are automatically plotted on the map and saved in the data set created on the parcels (usable lands) layer.

## 3.4    Context menu

**Context menu** (available by clicking the right mouse button) in the map window when object selection function is active.
Available options:
- **Information** - select an object (point, line, area) and read information about it:
  - point number and code
  - layer where selected object is located
  - closed object type (parcel, building etc.), area, circumference
- **Set as editable -** sets layer on which selected object is located as editable
- **Snapping -**  open a window with snapping settings
- **Edit -** edit structure of object
- **Copy -** copy point e.g. when a lamp-post also supports an electric traction wire
- **Remove -**  delete selected object
- **Remove all -** remove all objects selected by a rectangle selection tool
- **Transfer to... -** transfer selected object to a different layer
- **Frontages -**  generate frontages for the selected object
- **Fill object:**
  - Stairs - generate a stairs
  - Scarps - generate a scarp
  - Retaining wall - insert a retaining wall symbol
  Use these options when a closed object or an open object (polyline) is selected
- **Object division -** with any given division line
- **Group into linear segments -** change selected open or close object to separate linear segments
- **Combine segments** - combine linear segments into a closed object
- **Close open object -** this option will close an open object by connecting its last and first point
- **Add description -**  add a description to selected point. Enables to display a number, spot heights etc.
- **Select in  table** - select point(s) in the table.
- **Change font -** change inscriptions font on the map
- **Insert reference** - add a reference mark to selected text
- **Remove reference** - remove a reference mark from selected text

## 3.5    Map icons

### 3.5.1  Documents attached to points and objects

 - attach a raster (scanned document) to any object (point, linear object, text etc.) on the map.

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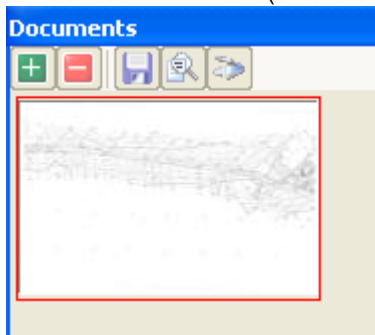
### 3.5.2 Zoom in

- zoom in on a selected fragment of the map. There are two ways to zoom in the view:
- by clicking (the left mouse button) at the place you want to resize
- by selecting an area to be zoomed - hold the left mouse button and move the mouse (hold the right mouse button to zoom out the view)

### 3.5.3 Zoom out

- zoom out the map view. Selected point will become a central point of the map in the zoomed out view.

### 3.5.4 Map alignment

- center the map view. Select a point to make it a central point of the map. You may also use arrow keys to move the map view in any direction.

### 3.5.5 Zoom all

- fit to window width. This function zooms the map to fit it all in the window width.

### 3.5.6 Previous view

- previous, next view. Use these icons to move back to the recent views of the map.

### 3.5.7 Map navigation window

- place the map navigation window in any area of the map view.

### 3.5.8 Overlay

- overlay selected map area. Enable the "snapping" option and select any area of the map. It is recommended to create a special layer for overlaying only.

### 3.5.9 Closed object

- closed object. Draw objects as closed figures (e.g. parcels, buildings)

### 3.5.10 Polyline

- polyline. Draw open objects as a sequence of segments.

### 3.5.11 Circle

- draw a circle. Press the left mouse button to indicate center point of the circle then move the mouse to indicate its radius (in meters) or click the right mouse button and enter an exact radius value.

### 3.5.12 Arc

- **draw an arc** in three steps. First indicate arc's initial point and end point then indicate any point between "located" on the arc line.

### 3.5.13 Curve

- **draw a B-spline** curve type. Indicate curve's initial point, endpoint and any point between them.

### 3.5.14 Point

**Insert a point by:**
- indication - this option enables to add a point to the map drawing. First indicate the place where the point will be located then in the opened dialogue window enter its number and if necessary adjust its coordinates.

- Insert a point from work table - if the map was created from different table than the work table then it is possible to insert a point from the work table on the map.

### 3.5.15 Frontages

- **insert frontage measure**. This option enables to enter text of length equal to the indicated line. After selecting this option choose font type and indicate the initial point and the endpoint of the line on which the frontage will be placed. The frontages may also be placed automatically for the whole object (context menu of the map) or the whole map ( option "Map->insert descriptions->Frontages)

### 3.5.16 Inscription

**- insert inscription**

After choosing this option enter text which will be added on the map and set text parameters. If it is required to add a text with multiple lines press ENTER in order to add another rows. Text height is

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shown in millimeters. Text width is determined automatically as 50% (or different value depending on the settings in Options ->Map) "% of width". If the inscription is to be placed under an angle enter the value of the angle or select the option "Adjust to line". If you plan to rotate the map set if the angle of inclination is calculated with respect to the grid of squares or the frame. In the case of setting with respect to the grid, the inscriptions will rotate together with the square grid. In the case of setting with respect to the frame, the inscriptions will not change their position. Entered text may overlay other elements of the map (other inscriptions, lines etc.). Additionally set if and on which side a reference mark will be placed.



### 3.5.17 Insert RTF document

 - click this icon to open the text editor window. Here you may add any text, pictures or tables and insert other documents (e.g. Word or Excel). Press the OK button when done. Created object may be placed in any location on the map. You may move it, rotate it or modify like an inscription.

### 3.5.18 Symbols

 - insert a symbol. This option makes it possible to insert symbols. If the option "attach without point (line)" in "Map -> " is disabled, a symbol can only be inserted at a point that is already present on the map (the option only works for points that have no code). Otherwise, the symbol is placed at the point of mouse click – which makes it possible to insert symbols such as a stadium, a lawn, etc., without inserting a point beforehand.
In the first step, select the symbol that will be assigned to the indicated points. Selection is done by

finding the appropriate group and indicating the symbol or entering the code.
If  selected symbol is already attached to one of the existing layers this layer will be highlighted. In other case choose a layer where selected points should be placed. If you don't choose any layer points will be placed on the "Zero layer". Press OK button and indicate points. A code completing table information will be given to each selected point.
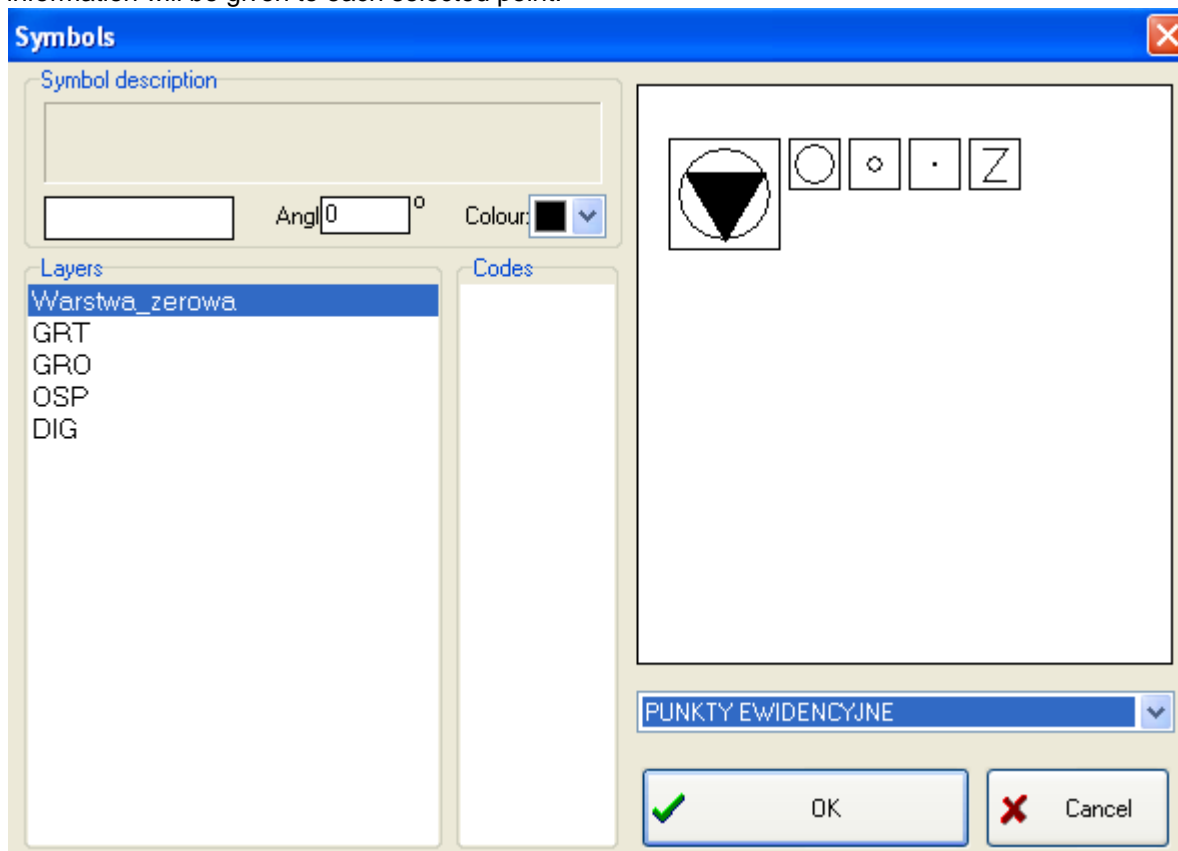


### 3.5.19  Recent symbols

 - displays a table with recently used codes. Select a code to add it on the map.

### 3.5.20  Calculations on the map

 - activates the option of surveys and calculations on the map.
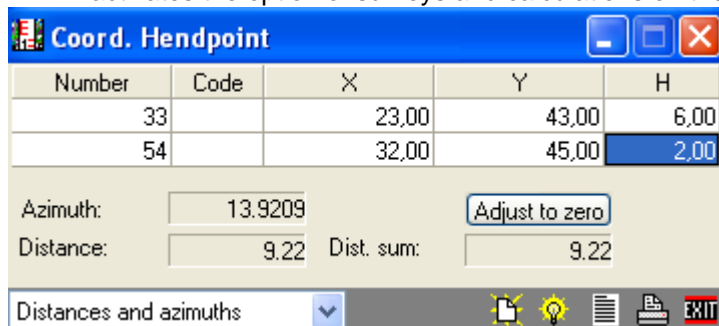


The data of points for calculations can be entered manually or by indicating points on the map with

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mouse.
The following options are available:

- calculation of distances and azimuths,
- calculation of coordinates of a point measured using the polar method,
- calculation of coordinates of a point measured using the orthogonal method. The start point and the end point of the measuring line can also be restored, if two or three points on the map corresponding to points on the sketch are known, and then the remaining details can be mapped from the measures on the sketch
- calculation of coordinates of a point located at the intersection of straight lines
- calculation of area – the option can be used for calculating areas of regions not being a closed object. Area information for closed objects can be obtained in a less labour-consuming way by highlighting the object and selecting the option "Information" from the context menu (right mouse button),
- calculation of angle from coordinates
- calculation of coordinates of a point using the method of angular and linear intersection
- projection of a point onto a straight line
- shift – translation of an object
- transmission from an instrument
- division of a segment into a given number of parts

Window icons:

- clear all entered data (Crtl N)

- perform calculation (Crtl O)

- save results for RAPORT option (Crtl A)

- print calculation results

- close window

## 3.5.21  Contour lines

**Manual interpolation of contour lines**. This function is available in the program versions including the module "Volumes and contour lines".

- division of a given segment   consists in indicating the skeleton lines between which the contour lines will run. After indicating two points (the points must have height) the segment between them is divided – contour line bend points are placed on the map. Contour distance (vertical interval) is set in the option "MAP -> Contour interval".

- connection of points – the next stage is to connect   the selected points with a contour line. After selecting the tool, indicate the course of the contour line (successive points through which the contour line is to run). This option makes it possible to connect points of the same height.

## 3.5.22  Selection mode

- activate select/edit an object function.
Place the cursor on the object you want to select and press left mouse button. If objects are covered one by another click till proper object will be selected. If you have many objects on different layers it is

convenient to set only one layer as selectable.

<span style="color:blue">In order to add a new object breaking point do as follows:</span>

- select an object
- grab (indicate and hold the left mouse button pressed) an object side on which a new bend point will be added,
- drag the side bend to the new point.

<span style="color:blue">In order to remove or change object breaking point do as follows:</span>

- select an object
- grab (indicate and hold left mouse button) the bend point you want to remove
- drag it to other point (to shift point) or on any empty place (to remove point)

### 3.5.23  Snapping options

- opens a window with snapping options. Previously it was a temporary window, now you may place it anywhere within the map view.
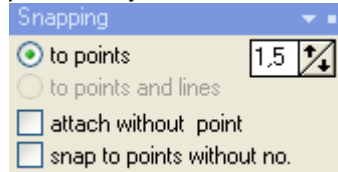
Snap to points and snapping range.

Attach without a point - draw "in open air". Red dot signalizes insertion of a point.

### 3.5.24  Line style

- <span style="color:blue">line style.</span> Default line style was set in the layer settings. You may change it. In opened window set  line style, color and width. If you want to go back to default settings highlight  the upper left line and press OK.

### 3.5.25  Object color
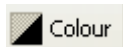
- When drawing an object you may change its color even though it was previously defined in the layer settings. Click on  the "default color" option to restore original settings.

### 3.5.26  Square grid

- <span style="color:blue">Enabling the square grid drawing</span>. The first click results in drawing a grid of crosses, the second click – drawing a grid with solid lines, the third click – disabling the square grid drawing.

### 3.5.27  Points description

- <span style="color:blue">description of points</span>. The option makes it possible to insert a description of points in two modes:

- description preview (working description) that will not be printed (unless the option "numbers preview" is enabled before printout), plotted or exported externally. If the function All numbers is enabled – all numbers of points are printed, otherwise only these numbers are printed which do not obscure other numbers. The description size is calculated in points on the screen and it does not depend on the map magnification.
- description as text (constant description). It will be assigned to a layer. We specify:

**- font type**
**- font size**
**- font style**
**- position**:

        previous - if descriptions were previously transferred on the map new description will be located in this same place

        automatic - inserts descriptions at the calculated point (ignores all editorial shifts)

        delete - removes transferred descriptions from the map

**- angle with respect to the grid or the frame**.

In the case of setting with respect to the grid, the inscriptions will rotate together with the square grid.
In the case of setting with respect to the frame, the inscriptions will not change their position.
After pressing OK, the program will display a window in which the layer concerned by the description should be marked.
In the case of points, the zero layer should be highlighted, because points are located on this layer
**- inserting** a point number, in whole or in part, before or after separator

## 3.5.28   Information

    **- enabling (disabling) the function of displaying the information about objects.**
Disabling this function results in:

- after selecting a point with mouse: setting the corresponding row in the coordinates table (provided that the table window is opened), opening and setting the adequate record in the data sets window (provided that a set for the points has been created)
- after selecting a linear object with mouse (superficial or not): opening and setting the adequate record in the data sets window (provided that a set for the objects from the given layer has been created)

Indicating a point on the map on the screen presented below has resulted in opening the window "new\SDIP" which contains descriptive data for the points from the table "new" and the layer "SDIP". A record corresponding to the selected point has been set in the window. Because the indicated map element is a point object, in addition the record corresponding to it in the coordinates table has been displayed (window "Table: new").

## 3.5.29   Print

    **- print map.**
Printing can apply either to "All" (i.e. the whole map will appear in the printout window) or to the "Selected area" (this region should be defined with mouse, analogously as "Create closed object") or „Area limited by the selected object" (this object must be selected with mouse beforehand). We have added the new option "Printout scheme". A scheme defined for a given map can be saved in this window. A scheme includes all settings in the printout window and stores them under a name entered after clicking with mouse the floppy disk "save current settings as a scheme" visible nearby. Besides, we have added the button "Insert page layout on the map" which inserts an open object onto the zero layer at the place of printout. This can be helpful in the case of accurate editing of the map (arrangement, inscriptions) contained in the scope of the future printout.
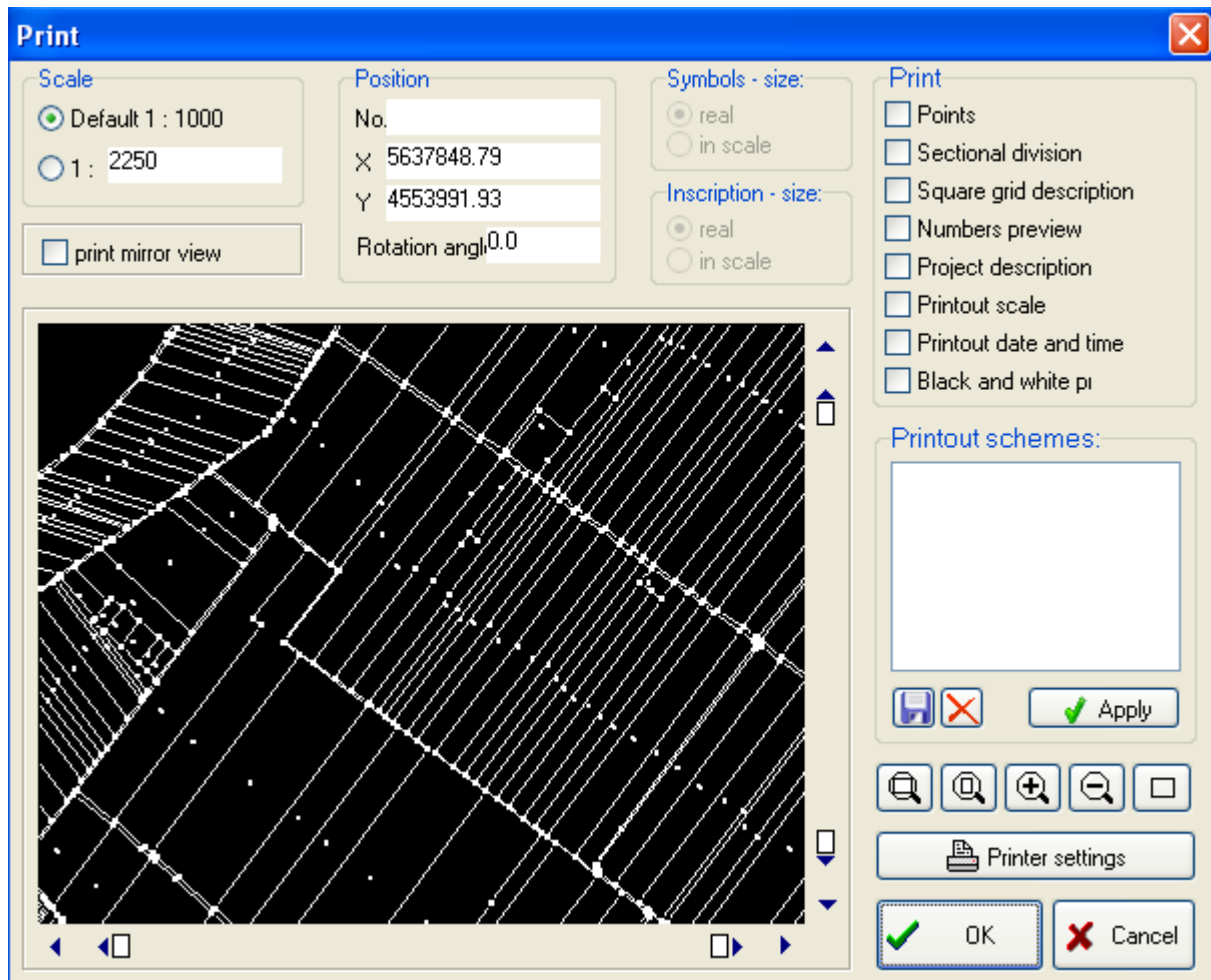
- the whole map and a rectangle, containing a region dependent on the printer settings page size and the map printout scale, are displayed in a dialog window. A map fragment for printout can be selected by moving with the mouse cursor.
- in the frame "Default scale" – the default scale of the printed map is given, in accordance with the scale of the generated map, and the user can change the map scale by themselves, however, it should be remembered that the location of inscriptions with respect to the map content on the printout will then be different than on the map preview on the screen, because they have been generated for the default scale. In this case, location of inscriptions on the map should be entered again or edited.
- the "Print mirror view" option enables to print a left-sided map drawing
- in the "Position" frame enter coordinates to determine the left bottom corner of the print area
- in the "Rotation angle" field enter a rotation angle of the work area (in degrees)
- in the frame "Size" – it can be configured whether symbols and inscriptions are to be printed in actual sizes, i.e. in accordance with the height determined during entering text onto the map. The second possibility is printing inscriptions and symbols in the scale, this results in a change of the size of inscriptions and symbols together with a change of the scale (e.g. if the default scale was 1:500, and the scale for the time of printout has been set to 1:1000, the height of inscriptions and the size of symbols will be two times smaller than entered during editing the inscriptions).
- in the "Print" frame set the size of points (1 to 5 pixels) without any code on the map. Besides, printing of the following elements can be enabled: sectional division, description of square grid, point numbers preview, description of the project, scale of printout, date and time of printout, and whether the printout should be black-and-white.

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### 3.5.30  Layers

- **show a dialogue window of the layers.**

### 3.5.31  Objects editor

- editor of objects.  The objects editor makes it possible to enter objects by specifying numbers (and coordinates, if the points are not it the table) of the points constituting the object contour. For closed objects, entering the same number as the first one results in saving the object automatically and proceeding to editing a new object. For open linear objects, saving occurs after pressing the second icon or selecting the option from the context menu available after pressing the right mouse button on the editor. All object points that have no numbers can also have a code assigned. While entering object points, a preview of the drawn object is visible, in addition, after pressing the icon

it is possible to generate an object drawing with a possibility of printout.



In the objects editor (for objects other than parcels and usable lands) it is possible to translate by a given vector. After highlighting an object from an editable layer, press the right button and select the option "Edit". After pressing the   button, it is possible to enter the value of shift along X and Y axis. In addition, the action type can be set:

- "+" - add (subtract) entered values from the coordinates
- "*" - multiply
- "/" - divide

Performing an object translation operation results in a change of coordinates of the points in the table (provided that the object was attached to points existing in the table), therefore the position of other objects attached to the same points is also modified. After performing a translation, only the coordinates in the editor are modified. Actual saving of the translated object occurs only after pressing the button – save object.

 - move object. Generate a new object positioned to the left or right (depending on the icon sign)

 - add codes to object points without a code.

**Turn over points direction in "Objects editor" -** change object points sequence (use right mouse button for that option)

 **- renumber object points.** Concerns numbered points and points without a number (with @)

 - export (import) from (to) a text file

 - preview object on the map

Textual creation wizard
Wizard for textual creation of objects makes it possible to insert objects by specifying the numbers of points, e.g.: "1a 2a 55 70-75" will create an object connecting 1a with 2a with 55 with 70 with 71 with 72 with 73 with 74 with 75. The object is created after pressing the Enter key

## 3.5.32  K1 objects

 **Assistance in creation of objects in accordance with the instruction K1**.
The option facilitates drawing a map by prompting a line type, adequate texts and symbols for a given object K1. For example, we want to insert a hatchway. Select the appropriate group (Water supply network) and the appropriate object from the list or enter the code WLZ in the edit field (confirm the selection with Enter). Selection of the object results in activation of appropriate buttons. In our example, the following buttons become active:

- "Symbols" with the possibility to select symbols available for this object,
- "Texts" with the possibility to insert adequate texts,
- "Closed object" with the possibility to insert a building contour. Besides, in other cases it is also possible to insert a closed object or an open object. The program by itself defines the adequate layer in „Layers" and gives it attributes in accordance with the instruction K1
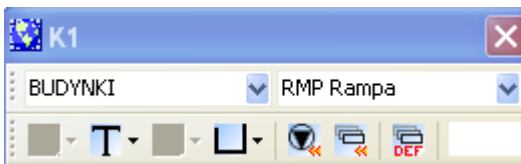


 - quick edition of recently used symbols and codes

 - displays a new "Object definition" window

 - new objects definition / open existing definition / save current definition.
Attention ! Current definition will be removed when creating a new definition.

 - add / edit / remove object

 - add / remove / edit existing symbol, text or object  assigned to  the code

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- combine layers. Transfer one layer onto another.

### 3.5.33  Refresh

- **redraw the map**. Refresh the view by redrawing the whole map.

### 3.5.34  Copy to clipboard

- **copy to clipboard.**  Copy the map window content to a report. Click this icon, enter the report and there select where to insert the content then click on the "Paste" icon.

### 3.5.35  Copy selected points

- copy to clipboard. Copy points selected on the map and paste them in the calculation modules.

### 3.5.36  Legend

cos jest popieprzone w ad 1A (re 1 A)

- legend. Opens a legend window with options as follows:

1. **Layers** - layers management (see description below)
2. **Calculations** - a list of all calculations and tasks. Use this option to find and open a task quickly without a necessity to use the calculation module from the main menu.
3. **Rasters** - rasters management
4. **Databases** - a list of all databases created for opened project
5. **Views** - see description below

Re. 1 Layers

- set layers in this folder as visible

- set layers in this folder as invisible

- set layers in this folder as selectable

- set layers in this folder  as not selectable (signalized by red circle)

- set color and line type for all layers in this folder (see line style)

- create folder (layers may be grouped in folders)

- create layer

- show full map

- remove empty layers

- properties (layers statistics; number of: points, objects, inscriptions, rasters, broken lines distances sum, closed objects surface area sum)

Re. 1 A)  **Layer**

- set layer as visible/invisible (visible layer is checked)

- set color and line type (see line style)

- set fill pattern (see line style)

- set layer as selectable/ not selectable. Red circle indicates a not selectable layer.

- set layer as not editable

- set layer type as "parcels"

- set layer type as "buildings"

- set layer type as "usable land"

- set layer type as "other"

- show full map

- clear layer

- change layer name

- remove layer

- set as not printable

**Re. 3 Rasters**

- opens "raster fit" window

- set rasters in this folder as visible

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- set rasters in this folder as invisible

- add raster ( RCF file format)

- remove rasters form this folder

- create folder (raster may be grouped in folders)

- update raster path

**Re. 3 A)**

**-** set raster as visible/invisible. Red circle indicates an invisible layer

- remove raster

- move raster (insert shift parameters)

- update raster path

- properties (raster information)

### 3.5.37  Views

Click  the "Save current view" icon to save current map view. Use "Apply view" option to load previously saved views. To remove saved views click on
the "Remove view" icon.
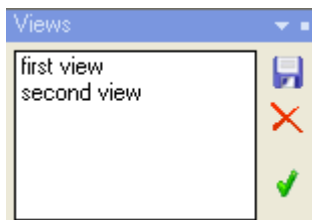
### 3.5.38  Switch over to table

-  switching over to points table.

### 3.5.39 Exit

 - close the map window.

### 3.5.40 Mouse roller

Roll a mouse roller to zoom in and zoom out the map view. Press and hold the mouse roller to move the map. (parameters may be changed in program options)
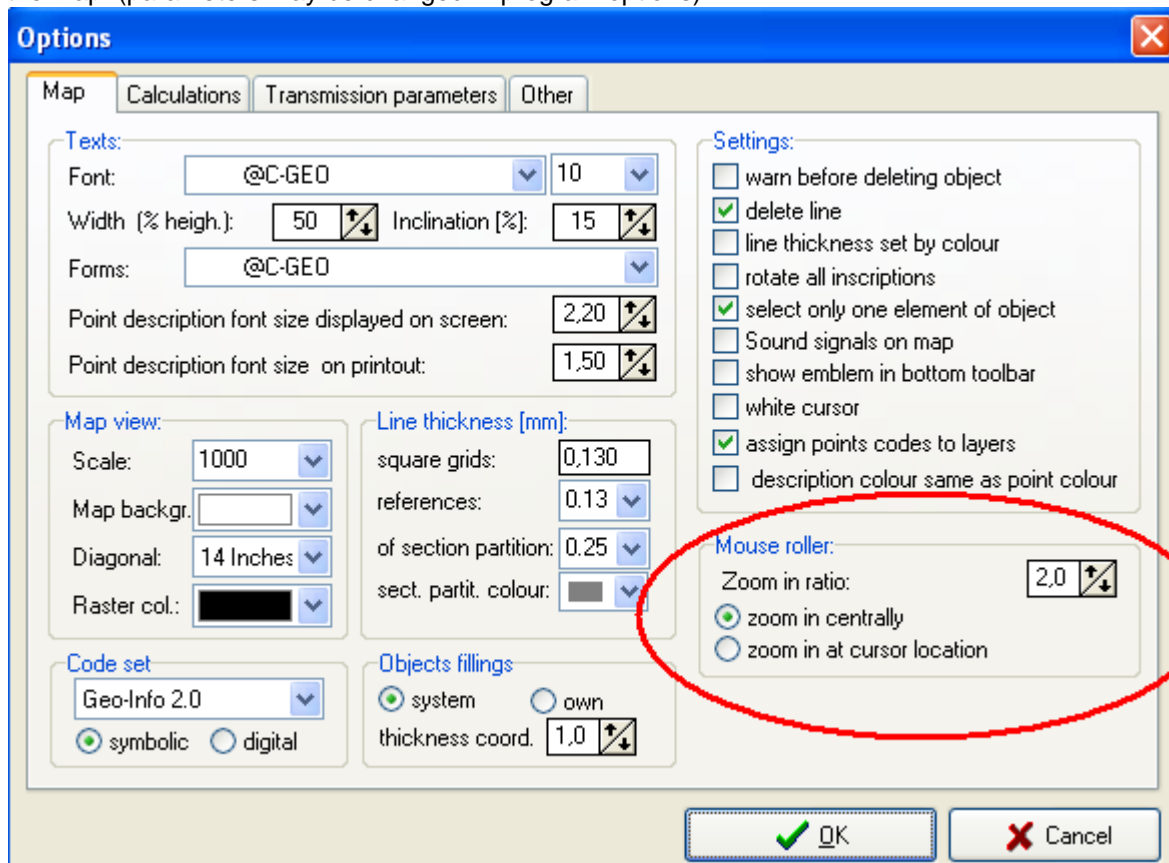


### 3.5.41 Additional toolbar

Additional toolbar consists of options as follows:

**1. Project options**
**2. Add descriptions**
**3. Change object location and attributes**

#### 3.5.41.1 Projection options

**Project options**

 - point on offset. A straight line should be indicated by clicking the line or its start or end, or by specifying the starting and ending numbers of the straight line from the keyboard. Then enter the value

of current and offset and the number of the calculated point. After specifying the data, the icon:
will appear, making it possible to perform calculations.

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 · - determination of a straight line perpendicular to a given line. After indicating a given straight line (with mouse or from keyboard), indicate the start point of the line being determined, by specifying its number, indicating it on the map, or selecting the line on which it should be located and specifying the value of frontage from the start of the given line (the perpendicular straight line will be placed at the distance equal to the given frontage). Next, specify the number of the end point of the perpendicular straight line, or indicate it on the map, or possibly specify the straight line on which it should be placed and specify the value of frontage from the start of the line to the point. Position of the second end of the perpendicular straight line can also be determined graphically by indicating the place of its ending

 - determination of a straight line parallel to a given line. After selecting a given straight line, specify the position of the starting point of the parallel straight line (indication of a point or a straight line and current on which it is located). The second point of the parallel straight line can be determined by specifying the straight line on which it is located, specifying the value of shift from the first point of the straight line being determined, or indicating graphically the end of the straight line.

 - determination of a straight line at a given angle to a given line. After selecting a given straight line, specify the position of the starting point of the straight line at an angle to the given line (by indicating a point or a straight line and current on which it is located). The second point of the straight line can be determined by specifying the straight line on which it is located, specifying the value of shift from the first point of the straight line being determined, or indicating graphically the end of the straight line.

 - determination of a straight line at a given azimuth to a given line. Specify the position of the starting point of the straight line at a given azimuth (by indicating a point or a straight line and current on which it is located). The second point of the straight line can be determined by specifying the straight line on which it is located, specifying the value of shift from the first point of the straight line being determined, or indicating graphically the end of the straight line.

 - projection of a point onto a straight line. A given straight line should be specified by indicating the start and the end with mouse or by clicking on a straight line. Then specify the point being projected (enter the number or indicate with mouse). After performing calculation and specifying the number of the projected point, it can be seen on the map.

 - intersection of straight lines. Indicate the first and the second straight line, and possibly their rotation angles and value of shifts of the straight lines. In addition it can be specified whether the rotation angle is calculated from the middle of the straight lines or from their start. After specifying the number and performing calculation, the new point is placed on the map.

 · - division of an object into a given area. The option makes it possible to divide a selected object by specifying the designed area and the division line. Select an object and press the button. Then the division window will appear, making it possible to divide the selected object by specifying the designed area and the division line. The division can be performed with a parallel straight line, a perpendicular straight line, a straight line at an angle, or a straight line at a given azimuth. Besides, there is an option to divide with a division line running through a constant point. This option makes it possible to divide the object into the given area, assuming that one point of the division line is constant. To perform the division, select the type of the division line: through a point, specify the point number (it must belong to the object being divided), specify the area for determination, and specify the number of the new point after division. After entering the desired criteria, the program automatically determines the course of the division line and the coordinates of the new points. Pressing the button <OK.> after performed division results in modifying the object on the map (two independent objects are created).

### 3.5.41.2  Add descriptions

 · - insert point description. Point description can be a number or XYZ coordinates. Choose the

description type and set description parameters: font type, style, size etc. Select one point or more points (use rectangle selection tool the same way as for zoom in function) then click [ 12→ Insert ] icon to describe selected points.

- insert a line (frontage) description. First set parameters: add "-hypens-" description location (over, under or on the line) and text style (font size, type, etc.)

- insert description in current measure format. Select a straight line where a description should be placed, then enter current measure, text parameters (font, style etc.) and on which side of the selected line the description should appear. Click on [ 12→ Insert ] icon.

- insert angle value. Before indicating the points of straight lines for which the angle is to be given, the sequence of vertices must be specified (e.g. left, central, right), then the description parameters can be specified (font, style, etc.). Then indicate with mouse the points on which the straight lines constituting the angle are based.

### 3.5.41.3  Change objects and attributes location

- shift. Enter a shift value and move selected objects along X and Y axis.

- rotate.The function makes it possible to rotate an object (objects) about a given point (by specifying the coordinates or indicating on the map) by a given angle (counter-clockwise or clockwise).

- fill tool.  Select an object (objects) and choose its fill type and color.

- line style. Change a line style and  thickness for selected objects.

## 3.5.42  Bottom status bar

**Bottom status bar consists of information:**

| ⊞ ■ .11 | 1 : 2250 | ● No. | | Code | | X : 5639634.90 | Y : 4553428.40 | ● H | | Editable : |
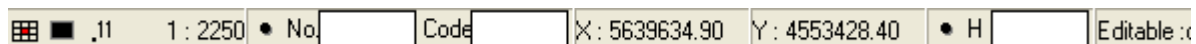
- selection of a working region of the map (speeding up the work on the map in large projects). Speeding up the work with the map is achieved by screening the map content and selecting for further processing only this fragment in which the user is interested.
Speeding up is dependent on the size of the region selected for editing.
The option is started after pressing the button located in the lower left corner of the map window. The region for processing can be selected in a dialog window, using 3 possibilities:
- by selecting a map section (provided that the map is executed in full coordinates of the system 65);
- by indicating a region with mouse on the whole map preview;
- by entering the coordinates of the top left and the bottom right corner of the rectangle limiting the region
In order to go back to the whole map view click on:

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- show/hide points description.

1 : 2250 - current map scale. In order to set a specific scale press F2 button and enter the scale value.

• No. and • H - press the black dot, we can enter the point number and give it a height. This possibility is useful in the case of raster vectorisation, because the points can be given numbers and heights immediately, without the need to enter them in the working table (if they are necessary for us). Otherwise, the points will be invisible in the table and the program stores them with @. Other information are the mouse cursor coordinates and the information, which layer is currently selected

**Switch map background color:**

- quick change of map background color (black or white)

## 3.6    Layers

C-Geo program creates an object map. Objects are assigned to layers. If we do not use the tool K1, the layers should be "created" by ourselves.

**Available options:**
- **Add layer** - creates new layer
- **Remove** - delete selected layer (will remove all layer content; double confirmation is required for this operation)
- **Copy** - press "copy" button and select the layer. After pressing the button, select from the list the layer onto which the copy is to be written. In the next step, specify which elements are to be copied (objects, points, inscriptions). This option can be used e.g. for creating several versions of descriptive layers for various scales of the map.
- **Edit layer name** - change selected layer name
- **Clear layer** - remove all objects from selected layer
- **Layer statistics** - information about the quantity and types of objects existing on particular layer

**Layer attributes:**
1. Type - defines layer function; four types are available:

- parcels - the objects constituting boundaries of parcels will be placed on the layer,

- usable lands – the objects constituting boundaries of usable lands will be placed on the layer,

- buildings - the objects constituting boundaries of buildings will be placed on the layer,

- other - the objects constituting boundaries of other objects will be placed on the layer,

It is necessary to set a layer type to place calculated objects properly and for export/import function.

2. **Visible -**  set if selected layer will be drawn on the map
3. **Selectable -**  set if objects (points) located on a layer are to be selectable.  Selectability is a property which greatly facilitates attaching objects to points.
4. **Editable -**  set which objects (points) on a layer are to be editable (remove, change, add). Editability is a property which can be assigned to one layer only.
5. **Line type and layer color -** specifies the line style with which the objects are to be drawn. The specified style is the default style (while drawing, various line styles can be used for various objects from a given layer).
Color is an attribute assigned to all objects of a given layer.
Attributes from points 2-6 are set by double-clicking with mouse in an appropriate column.
6. **Fill -**  set fill type to be used to fill closed objects.
• no fill pattern means that layer is transparent (all underneath layers will be visible)
• map color - this color will be used for filling (layers underneath filled closed object will not be visible)
• layer color - this color will be used to fill closed objects
• fill pattern - six kinds of patterns

Attributes from points 2-6 are set by double-clicking with mouse in an appropriate column.
The attributes "Visible" and "Selectable" can be enabled (disabled) for all layers simultaneously by clicking the button "Visible" or "Selectable". The frame "Data set" informs whether a data set is created for the highlighted layer. Position of layers in the hierarchy of layers can be changed with keys "+" and "-".

## 3.7　　Codes - layers

**This option enables to assign a code to a layer.**
A list of codes that are  not assigned to any layer is displayed in the "Table codes" frame. Please remember to assign all codes to layers (do not leave any code in the "Table codes" frame).
The "Layer codes" frame contains a list of codes from selected layer.
The "Layers" frame contains a list of available layers. Use the "<<" button to remove selected code from a layer (transfers code from the "Layer codes" frame to the "Table codes" frame. Use the ">>" button for opposite operation. In order to add or delete a layer use the "Add layer" and "Remove layer" buttons.

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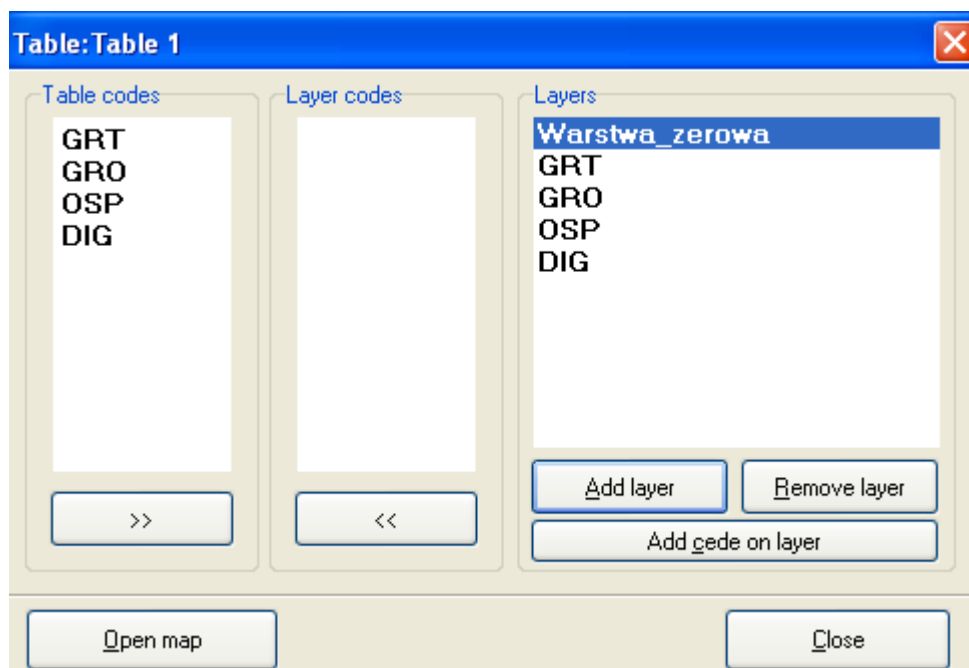


## 3.8 Form

Executing this option results in opening a new window, in which the map can be connected with a form.
Forms are text files (in the directory ...C-GEO6\FORMULAR\) with defined information about frames, texts, working fields and edit fields. Forms can be edited using any text editor or selecting the main menu option "OPTIONS -> Forms editor".
Forms in the program C-GEO can be for example: print of a topographical description, of a sketch, "description and map", design of real estate division, frame of the principal map, etc.

**Icons meaning:**

**- load form**. Text files containing form definitions have "frm" format. This option also enables to load files in "fr" format - these are binary files created by "Save form" option, along with a form definition they contain all entered changes like: filled text fields and information about inscribed map.

- **save form.** Save a form with all entered changes. A file in "fr" format will be created.

- **export form to raster file.** With a possibility to create a *.tfw file (georeference information)

- **insert form.** Insert a form on the map.

- **print form** on a printer (or a plotter)

- **printer (plotter) settings**

- **zoom in** form view on the screen

- **zoom out** form view on the screen

- **redraw** (refresh) form drawing

**- additional options:** divide a form into sheets, set printout displacement, "print mirror view" option.The option of division into sheets makes it possible to print the whole form in the case if it does not fit in the format available in the printing device. After pressing the button and selecting the option "divide form into pages", lines of division into individual pages are displayed.

**- close** form window

**Edit form:**

Texts in a form can be edited by indicating (clicking the inscription) with mouse.
Fields in which texts can be entered are filled with hashes in italics. After indicating the text, a text parameters window appears. The operator can change the text of the inscription, its height, style, color, position on the form (horizontally or vertically), and justification. During form editing, it can be shifted using cursor keys.

- The map (or its fragment) is entered after clicking with mouse in the field marked with a rectangle with diagonals. Then, in the dialog window:
- In the frame "Map" – select the map to be entered into the form from the list of maps included in the project. After selecting the map, its preview appears. The white rectangle marks the region being covered (at the selected scale) by the working field of the form. This rectangle can be shifted using mouse.
- In the frame „Scale" specify the scale in which the map will be placed in the form.
- In the frame position one can enter the coordinates of the map point which will be covered with the lower left corner of the working field of the form.

The point of covering can be changed using the button . The button makes it possible to specify the number of the point to which the working field is to be shifted. Instead of entering coordinates, an emblem can be entered, which will result in automatic calculation of adequate coordinates. After selecting the map, its preview appears. The white rectangle marks the region being covered (at the selected scale) by the working field of the form. This rectangle can be shifted using mouse. The angle of rotation of the working field (in degrees) can be entered in the field "Angle"

- In the frame "Square grid" – select whether and how the square grid is to be printed.
- In the frame "Size" – select whether symbols and inscriptions should be printed in actual sizes.
- In the frame "Printing" – select whether points without code, sectional division, and point numbers in the form of preview are to be printed, and black-and-white print.
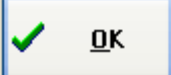
**Inscription**

Text:

Text parameters:

Height :

2.5
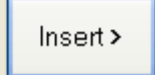
☑ Italics

☐ Bold

☐ Underline

⦿ Horizon

○ Vertica.

○ Vertica.

Colour ▮

Alignment

○ ○ ○
○ ⦿ ○
○ ○ ○

✔ **OK**    ✖ **Cancel**    Insert >
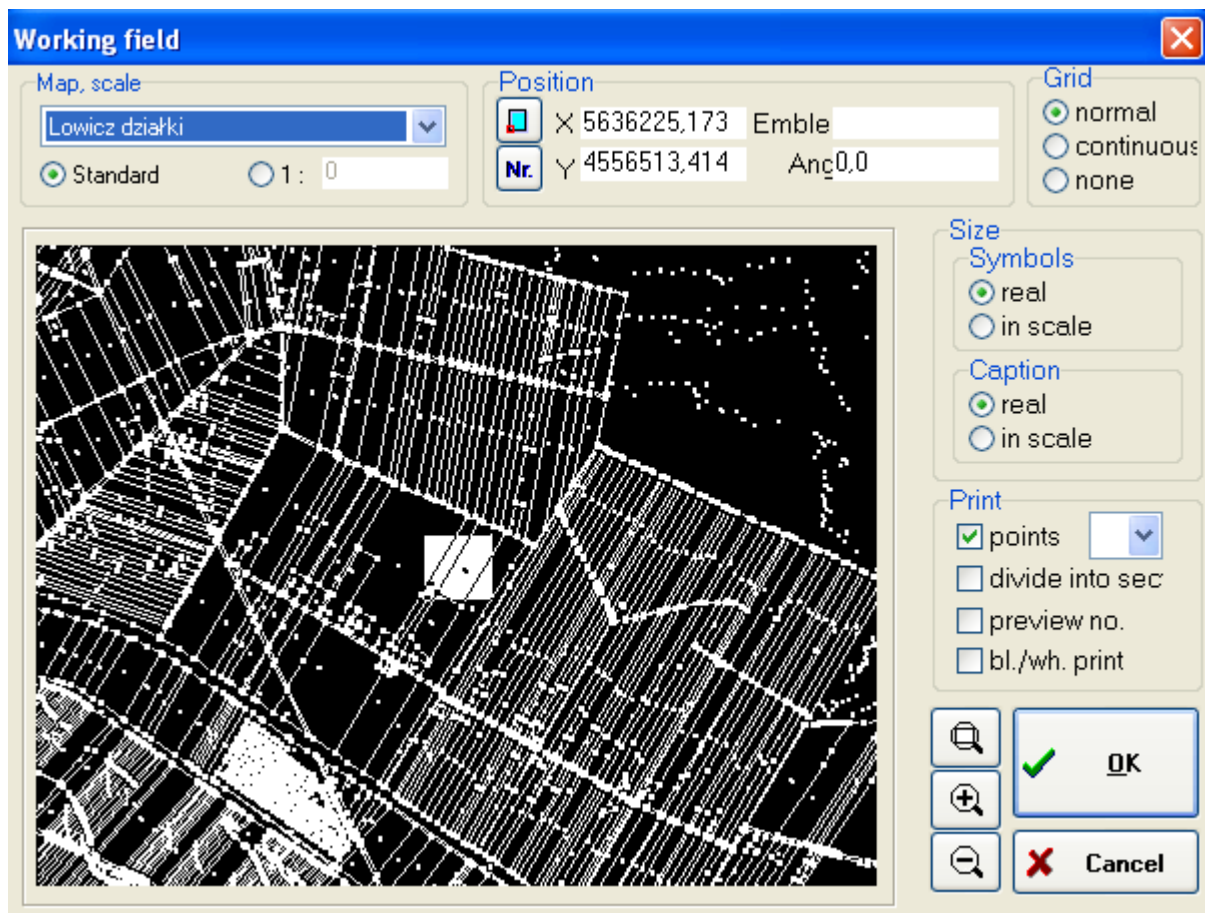
## 3.9    Snapping

• "to points" – selecting this option with disabled option "attach without point" results in that objects can only be created by indicating existing points.
Enabling the option "attach without point" makes it possible to insert an object (an object bend point) at any point. The fact that no snapping to an existing point occurred is then signalled by drawing a red dot and a sound signal, provided that this option is enabled. Snap to points without number – a possibility to snap to points with @
• "to points and lines" - this option is active only when "attach without a point" option is turned on.
• "snapping range" - set a circle radius (in mm) to determine the snapping area
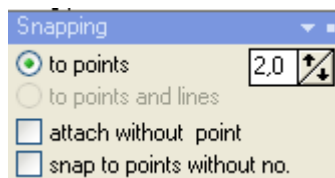


## 3.10    Change of standard scale

• Change of the scale in which texts and symbols are drawn..

## 3.11   Points display settings

- Set  if points without a code or a number (inserted directly on the and marked with @ symbol) are visible on the screen.

## 3.12   Sectional division (square grid)

- Enabling or disabling the sectional division. Before enabling this option, see whether a correct zone is specified in the options

## 3.13   Insert descriptions

This option makes it possible to attach a description to points (numbers, coordinates) or linear objects. First choose the layer with objects you want to describe then set text attributes (style, size etc.)
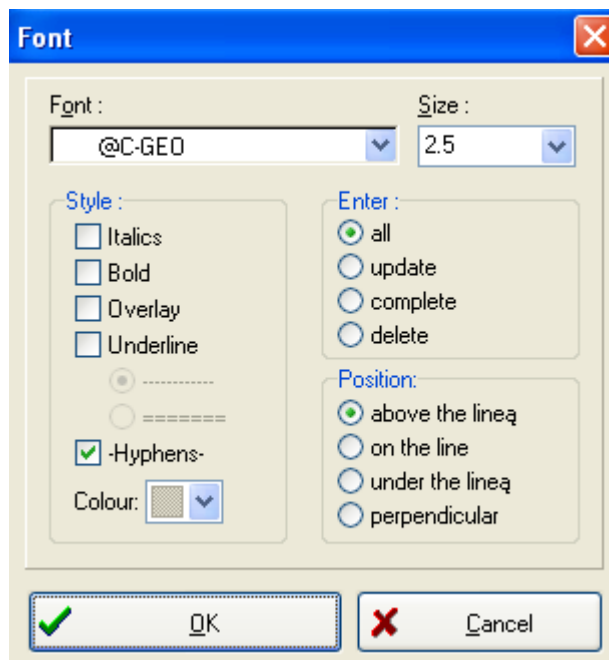


**Frontages must have specified:**
- **style,**
- **insert**:
    - all - add descriptions to all objects,
    -  update - change only those descriptions which were changed as a result of editing the object,
    - complete - add a description to all objects without a description
    - delete - remove objects
- **overlay** - entered text may overlay the map content (this option is useful to palce descriptions on a line)
- **position** - description position on the map
    The operation of inserting descriptions is performed for all objects from the selected layer.
    Texts which are descriptions are placed on an editable layer. If point descriptions are inserted, then after selecting the font, also select the values to be placed near points (number, X, Y, H).

## 3.14   Save template

Creates a file with saved information about:
- layers - layer names and parameters

- codes assignment to layers
- data file structure in layers

You may load a template whenever you start creating a new map (Table->Create map option). This way it will not be necessary to create layers and data sets manually.

## 3.15   Find point

Option makes it possible  to:
- find a point of a known number on the map. After entering the point number and the scale in which the map is to be displayed, the found point is marked and placed in the middle of the map window.
- display a map fragment by specifying the center coordinates and the circle radius,
- display a map fragment by specifying the minimum and maximum values of the coordinates X and Y.
- find an inscription
- possibility of finding whole sections e.g. after entering the section 531.441.123 we should obtain a view of the given section on the screen
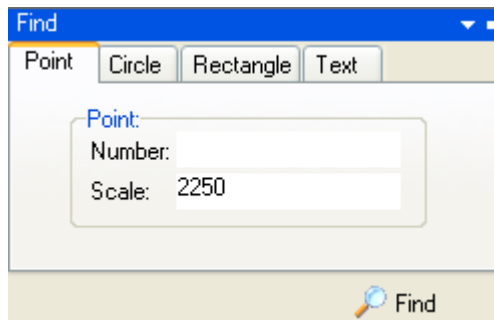


## 3.16   Map rotation

Rotation of the map drawing by a given angle (in degrees)
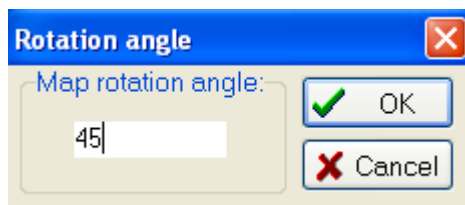


## 3.17   Raster

**Raster vectorisation** is performed in situations when we have a base map but we do not have a table of point coordinates. Therefore, this option makes it possible to obtain a vector map and point coordinates from an existing base map.
Sequence of actions:
- Using a scanner, we obtain the map image in form of a graphics file. It is good to scan the map so

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that the coordinate systems of the scanner and the map are parallel. This will result in a faster calculation process while rectifying the raster. The speed is also influenced by the raster size, colour and scanning resolution. A black-and-white raster of resolution 300 dpi is generally sufficient for geodesic purposes.

- Raster rectification
- Raster loading
- Raster vectorisation

## 3.17.1 Raster rectification

**Raster rectification**

This operation consists in loading a raster file and entering minimum two (Helmert transformation) or minimum three (affine transformation) fitting points, i.e. points on the raster for which ground coordinates are known. These points are entered in a table. After specifying a point number, adequate coordinates are fetched from the working set. If the point is not in the working set, its ground coordinates must be entered manually. Next, indicate with mouse the points in the raster corresponding to the entered terrain points.

Icons meaning:

- define raster parameters (shades of grey or number of colors)

- print raster rectification parameters (fitting points, errors, etc.)

- save raster rectification parameters (fitting points, errors, etc.) to the editor of reports

- choose raster transformation type (H - Helmert, A - affine)

- zoom in raster

- zoom out raster

- a preview window showing an enlarged fragment of the raster, this tool helps to indicate the rectification point.

- remove rectification point - removes highlighted point from the table

 - fit in grid of crosses - at least two crosses should be entered (left-bottom one and top-right one or if the raster is leveled only the left bottom corner of the square grid may be entered)

 - calculate coefficients of raster rectification

 - rectify raster - depending on the file size this operation may take couple of moments. Transferred raster file will be compressed and saved in  the folder of currently opened project.

 - when raster rectification is completed close opened window and go to the next step: "Load raster"

## 3.17.2  Load raster

Performing the raster rectification operation is not equal with loading the raster on the map background. On the left side of the dialogue window a list of rectified raster files is displayed. Use ">" and ">>" buttons to load a single raster or all rasters onto the map and on a specific layer. Loaded raster files are displayed on the right side of the dialogue window. Use "<" and "<<" buttons to remove raster files from the map. When the raster is loaded it should be visible on the map. If it is not visible make sure that current view displays same coordinates as the coordinates of loaded raster. Remember to set raster color different than the background of the map. The next step is raster vectorisation.
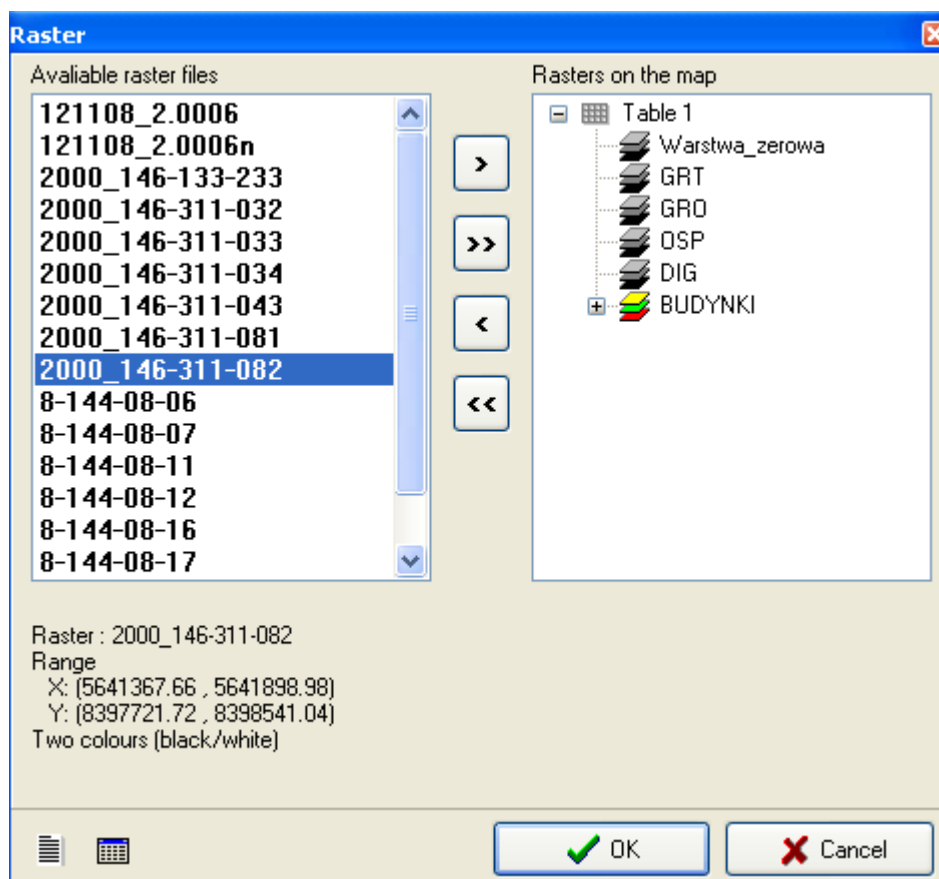
### 3.17.3 Raster vectorisation

**Raster vectorisation**

Before commencing vectorisation, set the snapping option to "attach without point" (menu also available under the right mouse button). Thus it will be possible to draw lines "in the air", on the background of the raster. Other actions are performed as while working normally on a map (creating layers, line types, colours, etc.). The point number and height fields are visible in the bottom bar of the screen. The user can enable or disable these fields, which makes it possible to number the bend points automatically and assign them height (e.g. for spot heights or contour line points) during vectorisation of objects. Enabling this function results in that while drawing objects, points of their bends are simultaneously stored in a coordinates table. If this option is not enabled, the program stores object bend points as hidden points.

### 3.17.4 Raster transformation

**Raster transformation**

Transformation of a single raster or a whole group of rasters from the system 65 to 2000 or vice versa. After selecting the option, specify the source directory of rasters (in general, this will be the C-Geo directory with rasters, i.e. c:/cgeo6/ raster) and specify the target directory – i.e. where the rasters after transformation are to be saved. We specify what is the primary and secondary system of rasters, and also a meridian or zone. Next, we specify a prefix for result rasters. We can also enable global corrections. After the transformation is performed, a report is displayed.

## 3.18   Contour lines

### 3.18.1  Contour interval

The option makes it possible to enter the value of contour interval for manual interpolation of contour

lines (        button on the map)

### 3.18.2  Draw markers on layers

A possibility to disable the display of markers (crosses) on curves.

## 3.19   Digitizer

This option is used for raster vectorisation using a digitiser. The option makes it possible to fit the digitiser into the map system – Helmert transformation or affine transformation is performed. Points of known coordinates are entered in the table. After specifying a point number, adequate coordinates are fetched from the working set. If the point is not in the working set, its ground coordinates must be entered manually. Next, indicate with digitiser indicator the points on the map corresponding to the entered terrain points. After entering the fitting points, transformation coefficients are calculated. From this moment it is possible to use all graphics functions on the map using the digitiser as a mouse. Before using the option Digitiser, configure the digitiser and parameters of the program C-Geo so that they are compatible. It is possible to set the speed, protocol, and other parameters of communication with the digitiser. It is important that the digitiser be able to operate in one of the digitiser modes available in C-Geo (Kurta, Wacom, Summa, Seiko). In the case of problems with configuration of digitiser or C-Geo in this scope, it is necessary to contact Softline.

## 3.20   Creation of objects

Parcels and usable lands can be entered graphically on the map by drawing the course of boundaries

without closing the parcels into closed objects. The tool            – open object – is used for this purpose, making it possible to draw a line consisting of a greater number of segments. After entering all segments of boundaries, use the option "Map -> Create objects" in order to automatically create objects (parcels or usable lands as closed objects are created from the entered data). A control of segment intersections and a control of "not snapping" to boundary points is performed during this process. These problems are signalled by a message and marking the erroneous place on the map. In order to have this tool operating correctly, it is necessary to set the layer type as parcels or usable lands

## 3.21   Map transformation

- **Conventional -**  transform the map with all its objects (inscriptions, points, closed objects, polylines, arcs, curves, parcels, usable land, buildings). First enter number of adjustment points (100 points is a maximum) from the map (primary system) then enter new coordinates for those points(secondary system). Entered data may be saved as a transformation task.  Two kinds of transformations are available - Helmert and affine transformation. When calculations are completed the program displays coefficients values and transformation errors then transforms the map according to new coordinates system.
- **Between systems -** map transformation between 1965<=>1992<=>2000 systems. Select which system is the primary one and  secondary system (zone or meridian).

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## 3.22 Map coherence control

Use this function if there are any errors on the map.

## 3.23 Presentation mode

Enabling (disabling) the presentation mode. Disabling the presentation mode results in replacing all lines K1 with broken lines and all symbols with a circle. This method of drawing speeds up refreshing the map. (useful for large maps and slow computers)
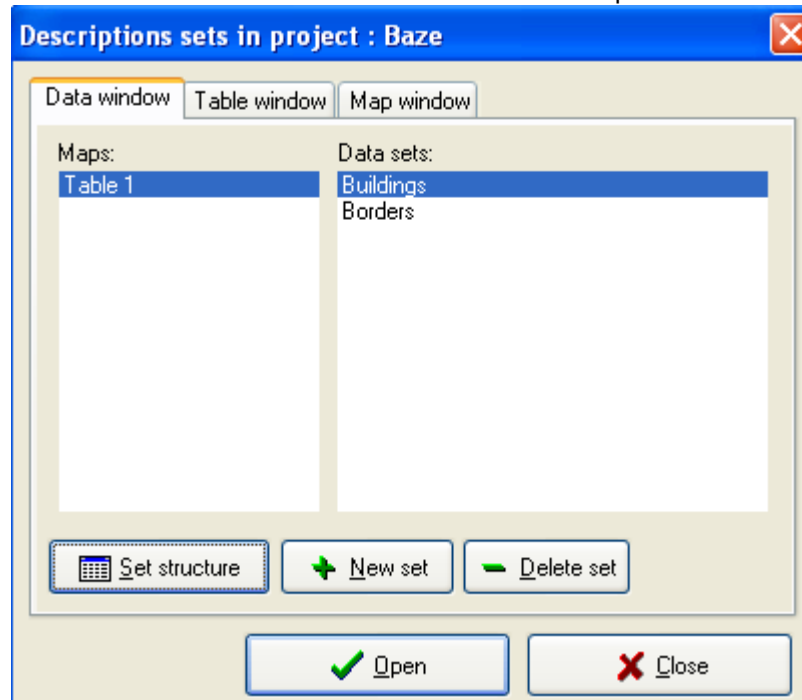
# Part

**IV**

# 4    DATA

## 4.1    Description sets in a project

**Description sets in the project**
Creation of data sets is realised in the main menu option "Data"



The list "Maps" contains a list of all maps contained in the project.
The list "Description sets" contains a list of layers for which description sets are already created (in the case if there is more than one map in the project – the list concerns the map which is currently highlighted). The button "Set structure" displays the structure of the highlighted set, making it possible to edit it. The button "Remove set" removes the highlighted data set. This results in losing all entered data. Creation of a new set is possible after selecting the button "New set". A dialog window is then displayed, listing the layers not having a data set created yet. After highlighting the layer we are interested in, we press the button "Points" or "Objects", depending on whether the set is to be created for point objects or linear objects. If some objects have already been present on the selected layer, then as many empty records as many objects are present on the layer will appear in the created data set. A column "Number" will be automatically created for point objects, and numbers from the point coordinates table will be copied
to this column.
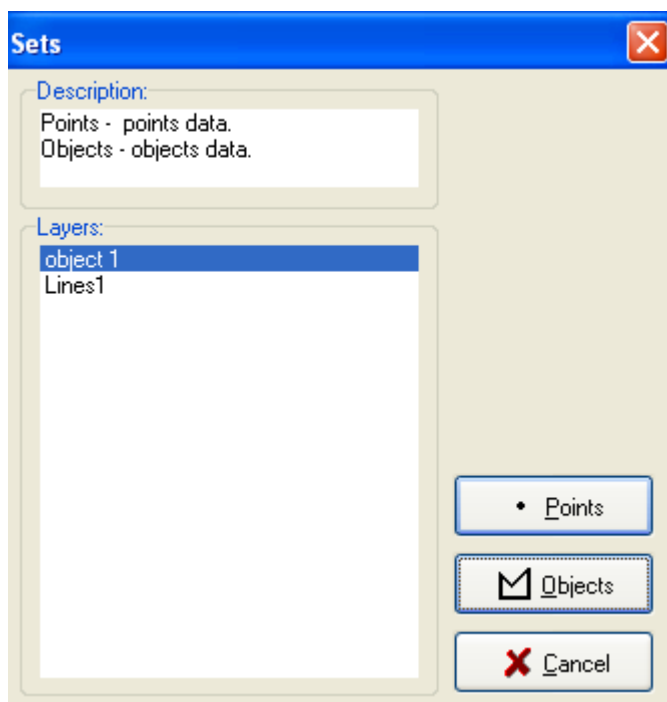
## 4.2    Data sets

Data sets are structures defined by the user. They can contain any information about objects. One data set can be created for each layer, either for linear objects or for points. For the layer of parcels and usable lands, a data set is created automatically, containing the columns: "Designation", "Parcel_number" (Usable_land_number), "Code", "Area". Information about the map and the layer concerned by the displayed set (map\layer) is



 contained in the header of the data set window. The window containing a data set can be opened by

clicking an object while the icon  in the map window is active, or by executing the option: "Data--Open"

**Meaning of the buttons in the data set window:**

 - **opens the window for defining** the structure of the data set
The button "Add field" makes it possible to add a new column to the data set. After pressing the button

in the frame "Information about field", enter its name and set the type (real number, integer number, text field, OLE object, date). For a text field, set the field length. All settings should be made very carefully, because if they need to be changed in the future, it will only be possible by removing the field (together with destroying all entered data) and adding it again. The field is created after selecting the button "OK." or pressing the button "Add field". In the latter case, it will be possible to add another column to the data set. In the frame "Function" it is possible to specify the function to be served by data entered in a given column. This is especially important for data sets for the layer of parcels and usable lands, making it possible to identify the column in which the parcel number is being searched for, and to which the calculated areas will be written. Setting the function "Area" is also used after pressing the icon



 - **transferring information from a data set onto the map**.
This option makes it possible to place the data from one column on the map. Selection of the column is made by placing the highlight in adequate column. It is possible to insert a description for one object or for all objects in the base. Data from the selected column are transferred in the form of inscriptions inserted:

- for closed objects – in the middle of the object,
- for open objects – above the middle side of the object,
- for point objects – next to the object.

After selecting the option, in a dialog window specify the type, size (in mm) and style of the font, and the position at which the inscription will be placed.

- Old position – if the inscriptions have already been transferred onto the map – a new inscription will be placed in the old place (if text shifts have been performed, they will be retained)
- Automatic position – inscriptions are inserted at a point calculated according to the rules described above (all editing shifts will be ignored),
- Delete – results in removing from the map the inscriptions transferred beforehand.
- Add – makes it possible to enter another description in a new row, e.g. when names and numbers of objects are in separate fields in the base, it is possible to place both these pieces of information by entering the first one, (option Automatic position), and then the second one (option Add).

 - **search for a record**. Searching is performed according to the column in which the highlight is present.

 - **calculate area or length** (perimeter) of objects and writing it into the column which has the type "Area" assigned. If there is no such column, a list of real type columns, into which it is possible to

write the calculated area, is displayed.

- **add to the data set a column X, Y and (or) H**, to which the point coordinates are assigned automatically. This option is only active for a data set for points.

- f**ind on the map an object** corresponding to the highlighted row in the data base window. The map is scaled so as to show the selected object.

- **printout** of the marked (character "X" in the column "Designation") records from the data base.

- **export of data to DBF format or to text format**. The selected objects can be exported, selecting also data base fields for export

- **import from a text file –** filling the fields with data from an external file
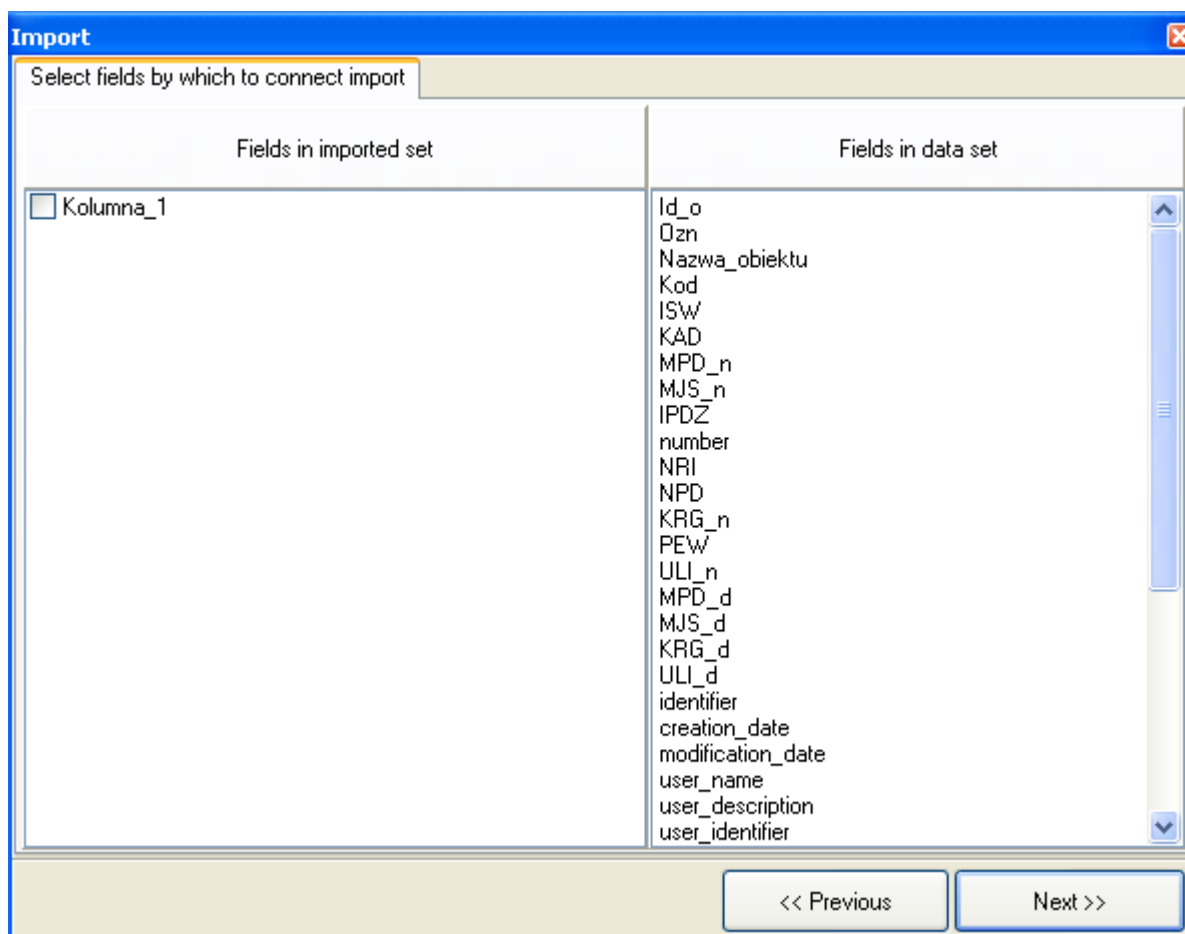
**?{** - **open a window for selecting objects with the SQL function**.

If information about objects (e.g. number, area, other properties) is present in the data base, using the SQL function it is possible to select objects (e.g. parcels) satisfying given conditions (e.g. of area larger than 50 ares, and numbers up to 150). For this purpose, start the data base window (option Data,

window Data sets), then press the icon ( **?{** ). This window presents the image of operations on the data base created for parcels, consisting of the fields: Parcel_number, Code, Area. In addition, the field Designation is visible, which will contain designations of the objects selected by the user. After clicking in the field "Action" in the row "Parcel_number", select the type of action, in this case the character "<", and in the field "Condition" enter the value "100", then in the row "Area", in the field "Action" select the character ">" and in the field "Condition" enter the value "50". After entering this information and pressing the button "Preview", it is possible to see the selected parcels. Whereas, after pressing the button "Mark", all selected objects are marked (the character "X" will appear in the column "Designation"). After closing the SQL window, the selected (marked) parcels can be printed (the print icon), selecting which pieces of information (fields from the data base) are to be printed.
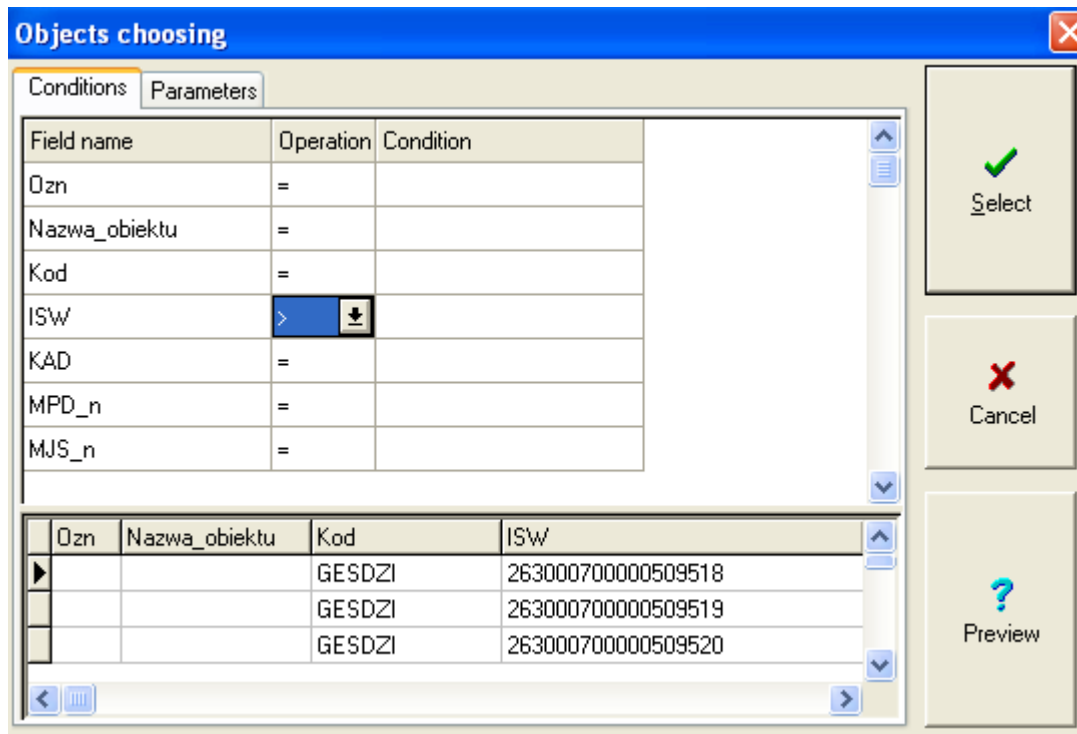
**- enable the browsing of fields of type MEMO and OLE**.

The OLE technology makes it possible to include e.g. drawings to C-Geo objects, and to browse these objects later. In order to include an OLE object, add an adequate field to the base structure, on a selected object position the mouse on the proper column (of OLE type), click the right mouse button, select the option "Edit OLE object". A window will then appear for editing and inserting the new OLE object. In order to insert a new object, press the icon "Load OLE object" and select the option "Create from file", then a window will appear for selecting the file from disk. After selecting the file, press the icon "Save to data set". The saved OLE object will be visible on the screen of the data base window.

    - **close the data set window.**

**Context menu is also active in the data bases window (available after pressing the right mouse button):**

- **Select** – marking one row in the data base row (the character "X" is inserted in the column "Designation"),
- **Select all** – marking all records of the data base,
- **Unselect all** – removing the marking for all records,
- **Reverse selection** – reverses the marking of records,
- **Delete object** <Ctrl K> – removing the highlighted object from the data set and from the map,
- **Edit object** <Ctrl O> – loading the highlighted object into the objects editor,
- **Edit OLE object** <Ctrl E> – editing an OLE type object – this option is active if highlight is present in a column of type "OLE object",
- **Field settings** <Ctrl U> – information about which field serves the function of the number and area field,
- **Fill field** <Ctrl W> – entering the given value for these objects which are not filled in the highlighted column.

- **Change scale** – makes it possible to specify whether the selected object is to be shown on the map in a scale such that only this object is visible, or this object is only to be found and shown in the scale in which the map is currently visible.
- **Sort** – sorting the data base according to the highlighted data column.
- **Renumber** – renumbering of numbers

# Part V
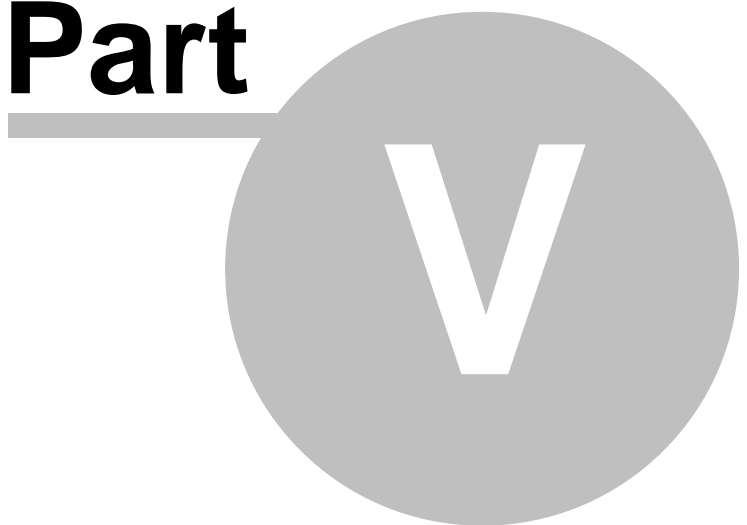
# 5 CALCULATIONS

## 5.1 General information

Before commencing calculations, in the projects window (File -> Projects) select a working table, i.e. the table the calculated points will be written to. The meaning of icons in calculation modules:

- new data - clears entered data

- load task - load from disk data saved beforehand.

- save task - save entered data

- calculate - perform calculations

- report - generating a report for the option executing this option results in performing the calculations and saving the results to a special set for printing later. Generation of a report is signalled with the message "Report saved!"

- print calculation results – selecting this option results in going to:

- what to include in report. Choose which calculation results will be included in the report.

- drawing. Draws a preview of calculated points.

All described options are also available in the context menu displayed after clicking the right mouse button on the task editor. Key shortcuts are assigned to the menu, making it possible to call a desired option directly from keyboard. Besides the above mentioned options, the menu also includes options for inserting an empty line in the editor and for deleting a line of data. The calculation modules toolbar

includes the icon: making it possible to enable or disable the possibility to edit point codes.

## 5.2 Parcels, usable lands

Calculation of the areas of parcels (usable lands) is closely connected to the map. If the map has no layer of parcels (usable lands) created, this layer should be created before commencing calculations. Make sure to set an adequate type of layer. If the objects of parcels (usable lands) are already created on the map, they can be loaded by clicking the icon load object.
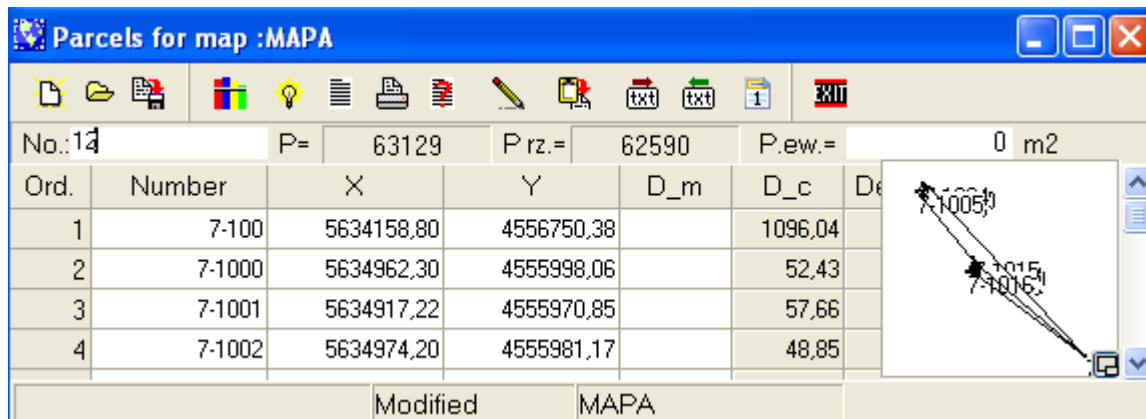
If no objects are created, an object is entered by specifying the numbers (and coordinates, if the points are not in the table) of points constituting the object contour. While entering the points of the object, a preview of the object being drawn is visible, and additionally, after pressing the icon  it is possible to generate a drawing of the object with a possibility of printout.

 - save object

 - calculate - perform area calculations

 - paste coordinates from the clipboard (if they have been copied from the coordinates table beforehand)

 - options containing information, what and how is to be printed

 -area adjustment. The option makes it possible to adjust an area to a given area, entered in the edit field "Adjustment to area". After pressing the key "Calculate", calculation of adjusted areas is performed.

If one of the areas located on the list is the area that we want other areas to adjust to, place highlight in adequate line and enable the field "adjust to area highlighted in the table". The adjusted areas are saved to a data set. If operator has entered the values of registered areas into the parcels base beforehand, it is also possible to adjust parcel areas to them. It is possible to print a report showing the differences between the registered area and the area calculated from the coordinates. It is also possible to enable the option taking into account the area reduction to the system 65.

Using the selection field in the last column, it is possible to exclude parcels from the adjustment process. In the context menu (available after pressing the right mouse button on the parcels list) there are the following options:
context menu (mouse left click on parcels list) contains options as follows:

- Select F5 - select (unselect) the highlighted parcel,
- Select all <+> - selects all parcels to be adjusted,
- Unselect all <-> - unselect all parcels to be adjusted,
- Invert selection <*> - select not selected parcels and deselect selected ones

## 5.3 Settlement of usable lands in parcels

Selecting this option starts settling the usable lands. The user can select settling usable lands to geodesic area, actual area (reduced to the system 65), or adjusted area. Calculations are executed for the map from the working table. After performing calculations, a window with results is displayed. The first calculated usable land is displayed in the column usable lands. Other usable lands are displayed after double-clicking with mouse in the desired row. The parcels to be printed in the report are marked in the last column. A menu is available under the right mouse button, making it possible to select, reverse selection, and unselect parcels.

## 5.4 Intersections

**The option makes it possible to calculate coordinates of a point determined using the methods of:**
- **linear intersection**

- **angular intersection**
- **resection**
- **intersection with adjustment**
- **combined intersection and resection**
- **spatial intersection**

The editor for each type of intersection consists of two parts: a table where the coordinates of tie points and the number (code) of the calculated point are entered, and edit fields where observations are entered. Proceeding to entering the observations occurs after pressing the key <Enter> while the last entered value in the coordinates table is highlighted.

The performed intersection is changed by selecting an appropriate tab.

## 5.4.1   Linear intersection

Example:

Given are coordinates of two points 1, 2 and distances from these points to the intersected point 100. Enter the data into the table as below:

| Number | | X | Y |
|--------|--|-------|--------|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |

Inters. point: 100
Left side: 60.00
Right side: 60.00

PERFORM CALCULATIONS (icon  )
Result: X=104.54   Y=75.00

## 5.4.2   Angular intersection

Example:

| Number | | X | Y |
|--------|--|-------|--------|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |
| w - 101 | | | |

Left angle: 60.00
Right angle: 60.00

PERFORM CALCULATIONS (icon  )
Result: X=84.41   Y=75.00

## 5.4.3   Resection

Example:

Given are coordinates of three points 1, 2, 3 and angles from the intersected point 102. Enter the data

| Number | | X | Y |
|---|---|---|---|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |
| 3 | | 100.00 | 75.00 |
| W - 102 | | | |

into the table as below:

Angle "a": 266.6667
Angle "b": 133.3333

PERFORM CALCULATIONS (icon    )
Result: X=64,43   Y=75.00

## 5.4.4   Intersection with adjustment

**Intersection with adjustment**
This is a module that makes it possible to determine the station coordinates (X, Y, H) on the basis of an arbitrarily measured geometrical structure (angular resection, angular intersection, linear intersection, angular and linear intersection, side intersection, and others). In the case of measuring redundant observations, coordinates of the intersected point are adjusted using the exact method. Coordinate errors are also calculated. Entering data begins from specifying the intersecting points and the intersected point. Specify the intersecting points in a sequence in which they would be seen by an observer standing at the intersected point: first the left point, then the centre point (if it is present), and finally the rightmost point, and the number of the intersected point in the fourth row. If spatial intersection will be calculated, specify also the heights H of points and the heights of mirrors or instrument at the points.
If horizontal angles are measured, they are entered in the second table according to the principle: left point, right point, and central point of the angle. The sequence of entering angles is also from the left to their right, looking from the intersected point.
If distances are present in the construction, they are entered in the third table, specifying the beginning, the end and the side length from the left to the right, looking from the intersected point. If spatial distances are measured, specify also zenith angles or elevation differences. These quantities should also be entered if spatial intersection is calculated. After performing calculations, coordinates of the intersected point appear next to this point, and possible errors of point determination appear in the table on the right side.
Example:
Calculate coordinates of the point 333 from data as in the drawing

*Observation error:*
mk=0,01000 g
md=0,010 m

*Edit data:*

| Number | X | Y | H | hc/i |
|---|---|---|---|---|
| 501 | 5405181.85 | 4704940.05 | | |
| 190 | 5401532.96 | 4702797.33 | | |
| 333 | | | | |

| 190 | 501 | 333 | 126.8000 | mx = |
|---|---|---|---|---|
| | | | | my = |
| | | | | mh = |
| | | | | mp = |
| | | | | m0 = |

| 190 | 333 | 2000.00 | |
|---|---|---|---|
| 501 | 333 | 3000.00 | |

PERFORM CALCULATIONS (icon        )

| | Numer | Xw | Yw | Hw |
|---|---|---|---|---|
| Calculating point | 333 | 5402192.68 | 4704685.39 | |

| mx = 0.011 | my = 0.012 | mh = | mp = 0.017 | m0 = 1.078 |
|---|---|---|---|---|

### 5.4.5 Combined intersection

Directions, reduced distances and optionally elevation differences to tie points (maximum 5) are entered as observations.
Calculation algorithm:
- coordinates of the tie points are calculated in the local system on the basis of directions and distances, assuming that the intersected point, i.e. the station has coordinates x=0.00 and y=0.00;
- Helmert transformation of the station from the local system is performed. The fitting points in the original system are the local coordinates, and in the secondary system – the ground coordinates of the tie points.
- the station height is determined as the average height calculated from individual tie points.

## 5.5 Intersection of straight lines

Calculation of coordinates of the points located at the intersection of two straight lines that can be additionally translated or twisted. In the table, enter the points determining the straight lines (with possible translation) and the numbers of points located at the intersection. Character of the entered quantity is shown in the hint appearing in the bottom line of the screen.
**Example**:
Coordinates of four points are given: 4, 5 – constituting one straight line and 6, 7 – constituting another straight line. Calculate coordinates of the point 103 at the intersection and translation along the straight line 6-7

| Number | X | Y | Number | | X | Y | L |
|---|---|---|---|---|---|---|---|
| 4 | 10.00 | 10.00 | 5 | | 20.00 | 20.00 | -1.00 |
| 6 | 15.00 | 10.00 | 7 | | 15.00 | 20.00 | |
| 103 | | | | | | | |

PERFORM CALCULATIONS  (icon   )
Result: X=15.00 Y=13.59

## 5.6     Intersection with sectional frame

Coordinates of two points are given: 8, 9 – constituting a straight line. Calculate coordinates of the point 104 located at the intersection with the sectional frame. (The map emblem can be determined by using the options of screening with a rectangle or by specifying the coordinates of the section corners).

| Number | Kod | X | Y |
|---|---|---|---|
| 8 | | 5492100.00 | 3751900.00 |
| 9 | | 5492100.00 | 3752100.00 |
| 104 | | | |

Emblem: 473-413-15

PERFORM CALCULATIONS  (icon   )
Result: X=5492100.00 Y=3752000.00

## 5.7     Azimuths, lengths, angles

**Calculation of azimuths and lengths or angles from coordinates.**
Examples:
- **Azimuths and distances**

Coordinates of two points are given: 1 and 2. Calculate the azimuth and length of the line connecting these two points. Enter data into the table as below:

| Number | Kod | X | Y |
|---|---|---|---|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |
| 100 | | | |

PERFORM CALCULATIONS  (icon   )
Result: Azimuth 100.00
        Distance 50.00

- **Angles**

Coordinates of three points are given: 1, 2, 3. Calculate the angle between the straight lines, where the point no. 3 is the vertex of the angle. Enter data into the table as below:

| Number LRC | X | Y |
|---|---|---|
| 1 | 50.00 | 50.00 |
| 2 | 50.00 | 100.00 |
| 3 | 100.00 | 75.00 |

PERFORM CALCULATIONS  (icon       )
Result:        Angle      340.9666
　　　Distance 1-3      55.90
　　　Distance 2-3      55.90

# 5.8　　Transformation of coordinates

**Transformation of coordinates**
The module makes it possible to perform transformation using the Helmert method, the affine method, or between systems. Selection of the recalculation method is performed by pressing the appropriate

icon: **H** , **A** , or ⟨65/92⟩ . In the Helmert transformation it is possible to use Hausbrandt corrections and to specify the method of calculating the transformation error (division by (n-2) or by n; where n = number of fitting points). The options are available under the right mouse button. In order to perform the recalculation, it is necessary to enter at least 2 (Helmert method) or at least 3 (affine method) fitting points, i.e. points whose coordinates are known both in the original system (Xp, Yp) and in the secondary system (Xw, Yw). After entering the fitting points, enter the transformed points, i.e. the points whose coordinates are only known in the original system. Switching over between entering the fitting points and entering the transformed points is performed by selecting the appropriate tab. It is possible to specify the numbering of the transformed points in the secondary system, using the context menu (the right mouse button) – it is possible to specify the numbering with a constant prefix (suffix) and of a given beginning of numbering, or to specify copying the numbering from the original system. The icon "Format of entered data" specifies the form in which the data are entered (grads, degrees or decimal degrees). Switching over the options, the program automatically recalculates the coordinates B and L. Transformation for values in degrees sets the accuracy of seconds to the accuracy of the coordinates X,Y from the option + two digits (the same order of accuracy after recalculation to metres). The reports and printout, both for the affine transformation and for the Helmert transformation, include information about corrections at the fitting points.
Example:
Perform transformation of coordinates to the system 65.
Specify coordinates of the fitting points:

| Lp | Number | Xp | Yp | Number | Xs | Ys |
|---|---|---|---|---|---|---|
| 1 | 1 | 50.00 | 50.00 | 1w | 5492050.00 | 3752050.00 |
| 2 | 2 | 50.00 | 100.00 | 2w | 5492050.00 | 3752100.00 |
| 3 | 3 | 100.00 | 75.00 | 3w | 5492100.00 | 3752075.00 |

Next, click the tab TRANSFORMED POINTS and specify the numbers of the points in the secondary system:

| Lp | Number | Xp | Yp | Number | Xs | Ys |
|---|---|---|---|---|---|---|
| 1 | 100 | 104.54 | 75.00 | 100w | | |
| 2 | 101 | 84.41 | 75.00 | 101w | | |
| 3 | 102 | 64.43 | 75.00 | 102w | | |
| 4 | 103 | 15.00 | 13.59 | 103w | | |

Click on PERFORM CALCULATIONS   (icon        )
Result:

| Nr | Xs | Ys |
|---|---|---|
| 100w | 5492104.54 | 3752075.00 |
| 101w | 5492084.41 | 3752075.00 |
| 102w | 5492064.43 | 3752075.00 |
| 103w | 5492015.00 | 3752013.59 |

## 5.9   Tacheometry

**Calculation of coordinates of points measured using the tacheometric method.**
In order to perform calculations enter: station number, instrument height and spot heights data.
Information about a spot height consists of the following values:
- spot height number

- reduced or not reduced distance depending on the setting - icon        or
- direction on the spot height

- zenith angle or elevation difference depending on the setting - icon        or
- height of the target (mirror)

In order to perform calculations, it is necessary to specify which spot heights are the tie points. This is performed by moving the highlight in the table to the spot height which is to be a tie point, and pressing

the key <F5> or the icon: . . . . . or selecting the option "Tie" from the context menu available after pressing the right mouse button. A point selected as a tie point is marked with red color in the column "Item".

- this icon makes it possible to sort the spot heights in ascending order of numbers

- makes it possible to renumber the spot heights. Specify the number of the first spot height, the numbering interval, and possibly a prefix or suffix.

**Context menu** available after pressing the right mouse button contains, besides the basic options of the module, also the following additional options:
- **angles book** – after performing calculations, it is possible to generate a task for the module "Azimuths, lengths, angles", containing the calculation of angles between the station and the tie points;
- **offset** – after entering the offset value at the highlighted spot height, the direction and distance are

recalculated in the tacheometric book;
- **vertical circle** – specification whether the measured vertical angles are zenith angles or vertical angles;
- **recalculate distances...** – recalculation of spatial distances to reduced distances and vice versa. After selecting this option, provided that there is data for performing calculations for all spot heights, the distances in the editor are recalculated.
- **recalculate angles...** – recalculation of zenith angles to elevation differences and vice versa. After selecting this option, provided that there is data for performing calculations for all spot heights, the angles in the editor are recalculated.
- **recalculate angles to grades** – recalculation of angles written in decimal degrees form or as degrees, minutes seconds.

If the station coordinates are unknown, then after pressing the icon (calculate) they can be determined from intersection to tie points. The station coordinates are determined according to the algorithm:
- coordinates of the tie points are calculated in the local system on the basis of directions and distances, assuming that the intersected point, i.e. the station has coordinates x=0.00 and y=0.00;
- Helmert transformation of the station from the local system is performed. The fitting points in the original system are the local coordinates, and in the secondary system – the ground coordinates of the tie points.
- the station height is determined as the average height calculated from individual tie points.

Data for calculations can be entered manually or transmitted from recorders. In order to start the data transmission module, press the button designated: . Before data transmission, select the appropriate type of recorder from the list available after pressing the button . Then press the button "Start transmission", and next, perform the actions listed in the upper field. For a correct transmission it is necessary that the port RS232, that the recorder is connected to, be compatible with the settings of transmission parameters.



If data transmission is proceeding correctly, the transmitted characters are appearing in the frame "Transmission". Besides the transmission, after selecting the tab "File conversion" it is possible to convert tacheometric data saved in other formats. It is possible to transmit data from recorders and

instruments:

| Transmission | Converssion |
|---|---|
| Psion Workabout | Sokkia SDR 5 |
| Psion XP, LZ (program M-Geo) | Psion – SET (*.odb) |
| Rec 500 | Nikon 300 |
| Rec 200 | Nikon 400 |
| Geodat 124 | Nikon 700 DTM 352 |
| Geodat 126 | Psion ImpexGeo (*.obs) |
| Sokkia (SDR 33) | Wild Gre 4 |
| Kern -Alphacord | Wild TC 600 (*.dat) |
| Wild Gre 4 | AEM |
| Elta 15 | Recota |
| Elta 50 R | Reta |
| Geodimetr | Geodimetr |
| Nikon DTM 300 | Toposet- Psion (*.pxf) |
| Nikon DTM 310, 400, NPL 350 | REC500 |
| Topcon GTS 210, 220, 230 N | Geodos- Psion (*.odb) |
| Topcon GTS 210, 220, 230 N (D*10) | Wild z modułem REC |
| RecElta | Geodat |
| Set 4 II C | Geodat 124 |
| Set 5 F, PowerSet, Set 500, 600 | Topcon (GTS-220/GPT-2000, 230N) |
| Topcon SSS GTS 500, 600, 700, GPT 3000 | FCTE |
| Elta R | Leica GSI |
| Elta 15 v. niemiecka | Set 4 II C |
| Elta C | RecElta |
| Leica GSI | Leica FRT |
| TerMap | Leica – format tekstowy C-Geo/M-Geo |
| Wild Gre 4 (hc i hi/100) | Leica TPS300/700 format IDEX |
| ACU - Trimble | Elta 50 R |
| Pentax | Psion ImpexGeo kod=numer (*.obs) |

Before printing the calculation results, it is possible to specify what values (columns) will be included in

the report (icon:  )

<span style="color:magenta">Example:</span>
Instrument station at the point no. 1. Measured directional tie to the point no. 2. The elevation
differences Dh and spatial distances have been measured, therefore click the appropriate icons (

). Enter the station "1", the instrument height "1.78".
Spot heights data are entered as below:

| Number | Spatial dist | Direction | Dh | Hc |
|---|---|---|---|---|
| 2 | | 100.0000 | | |
| 1000 | 29.40 | 52.5400 | 0.120 | 1.700 |
| 1001 | 48.94 | 37.1735 | 1.320 | |
| 1002 | 86.53 | 17.8633 | 3.421 | |
| 1003 | 75.05 | 39.8315 | 2.321 | |

Select the point no. 2 as TIE and click the icon {CALCULATE }. Values of deviations and results are displayed:

| Nr | X | Y |
|---|---|---|
| 1000 | 69.94 | 71.60 |
| 1001 | 90.82 | 76.97 |
| 1002 | 133.08 | 73.94 |
| 1003 | 110.80 | 93.93 |

## 5.10  Orthogonal calculations, projection

**Recalculation of orthogonal measures to rectangular coordinates and vice versa.**
The type of performed recalculation is selected using the buttons in the toolbar ( ). It is also possible to transmit the offsets data recorded in Psion WorkAbout in the program MGEO – then the offsets data also contain the observations DH – elevation differences, which makes it possible to calculate the heights of points. In order to perform calculation of coordinates from offsets, first enter the tie data and then the points data. For the tie data, after selecting the option "calculate", calculation of length from coordinates and deviation is performed. Switching over between the editors of these values is preformed by clicking an appropriate tab.
Example:
• calculation of coordinates from rectangular measures (icon {OFFSETS -> COORDINATES} pressed)
Given are coordinates of two points 1, 2. Calculate the coordinates of three offset points: 10, 11 and 12 while points 10 and 11 are on the offset to the right and point 12 is on the offset to the left.  Enter the data into the table as below:

Tie data

| Number | | X | Y |
|---|---|---|---|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |

Points data

| Number | | Distance | Offset |
|---|---|---|---|
| 10 | | 10.33 | 3.54 |
| 11 | | 15.18 | 7.34 |
| 12 | | 24.22 | -5.22 |

PERFORM CALCULATIONS (icon )
Results:

| Number | X | Y |
|---|---|---|
| 10 | 46.46 | 60.33 |
| 11 | 42.66 | 65.18 |
| 12 | 55.22 | 74.22 |

- calculation of offsets from coordinates (icon {COORDINATES -> OFFSETS} pressed)

Given are coordinates of two points 1, 2. Project three points on the straight line connecting points 1 and 2 and calculate their offsets. Enter the data into the table as below:

Tie data:

| Number | Kod | X | Y |
|---|---|---|---|
| 1 | | 50.00 | 50.00 |
| 2 | | 50.00 | 100.00 |

Points data:

| Number | X | Y |
|---|---|---|
| 10 | 46.46 | 60.33 |
| 11 | 42.66 | 65.18 |
| 12 | 55.22 | 74.22 |

PERFORM CALCULATIONS (icon )
Results:

| Number | Kod | Distance | Offset |
|---|---|---|---|
| 10 | | 10.33 | 3.54 |
| 11 | | 15.18 | 7.34 |
| 12 | | 24.22 | -5.22 |

## 5.11    Polar calculations, alignment work

**The option makes it possible to recalculation polar measures to rectangular coordinates and vice versa.**

The type of performed recalculation is selected using the buttons in the toolbar ( ). In order to perform calculation, first enter the tie data and then the points data. For the tie data, after pressing the sequence <Ctrl O> (or selecting the appropriate icon), calculation of tie deviation is performed. Switching over between the editors of the tie data and the points data is performed by clicking an appropriate tab.

<span style="color:magenta">Example:</span>
- calculation of coordinates from polar measures (icon {POLAR MEASURES -> COORDINATES} pressed) Coordinates of two points are given: 1, 2. Calculate the coordinates of three points, having measured the directions and distances to these points. Enter data in the table as below:

Tie data

| Number | | X | Y | Direction |
|---|---|---|---|---|
| 1 | | 50.00 | 50.00 | |
| 2 | | 50.00 | 100.00 | 100.00 |

Points data

| Number | | Direction | Distance |
|---|---|---|---|
| 13 | | 85.2420 | 30.00 |
| 14 | | 110.2340 | 29.45 |
| 15 | | 146.7660 | 15.33 |

PERFORM CALCULATIONS (icon )
Results:

| Number | X | Y |
|---|---|---|
| 13 | 56.89 | 79.20 |
| 14 | 45.29 | 79.07 |
| 15 | 39.72 | 61.38 |

- calculation of polar measures from coordinates (icon {COORDINATES -> POLAR MEASURES} pressed) Coordinates of two points are given: 1, 2. Calculate the polar measures to three point from the point no. 1. Enter data in the table as below:

Tie data

| Number | Kod | X | Y | Direction |
|---|---|---|---|---|
| 1 | | 50.00 | 50.00 | |
| 2 | | 50.00 | 100.00 | 100.00 |

Points data

| Number | X | Y |
|---|---|---|
| 13 | 56.89 | 79.20 |
| 14 | 45.29 | 79.07 |
| 15 | 39.72 | 61.38 |

PERFORM CALCULATIONS (icon )

| Number | | Direction | Distance |
|---|---|---|---|
| 13 | | 85.2420 | 30.00 |
| 14 | | 110.2340 | 29.45 |
| 15 | | 146.7660 | 15.33 |

## 5.12  Polygonal traverse

**Module for calculating the coordinates of points measured in a polygonal traverse.**
Data are entered in two tables. Data of tie points are entered in the upper table. Depending on the possessed tie data, it is possible to enter two points determining the tie side or one point and azimuth. The tie data are entered in accordance with the designations presented in the drawing next to the table. This icon makes it possible to generate polygonal traverses on the basis of observations at tacheometric stations. During a tacheometry measurement, apart from the spot heights, record also the successive points of the polygonal traverse, marking them as ties. Make sure that two ties (to the previous and the next point of the traverse) are measured at all stations (apart from the first and the last station). The traverse points can be measured at two positions of the telescope, then the same point number must be specified for measurements at both positions of the telescope. After transmission of tacheometric stations to C-Geo, the described function makes it possible to create a polygonal traverse, consisting of maximum 1000 stations: If tacheometric stations will be present in the current project, a table will appear, facilitating the selection of the starting point of the traverse, and then the selection of successive points of the traverse from the available points of tacheometric ties.
Example:
An open polygonal traverse consists of six points. In the upper table, specify the numbers of the tie points:

| | | Number | | X | Y |
|---|---|---|---|---|---|
| Tie | P1 | 20 | | 20.00 | 20.00 |
| Tie | P2 | 21 | | 60.00 | 60.00 |
| Tie | K1 | 24 | | 20.00 | 180.00 |
| Tie | K2 | 25 | | 60.00 | 220.00 |

In the lower table, enter:

| Ord | Number | | Angle | Distance |
|-----|--------|---|----------|----------|
| 1 | 21 | | 300.0000 | |
| | | | | 56.57 |
| 2 | 22 | | 100.0000 | |
| | | | | 56.57 |
| 3 | 23 | | 300.0000 | |
| | | | | 56.57 |
| 4 | 24 | | 100.0000 | |

PERFORM CALCULATIONS (icon .   )
Results:

| Number | X | Y |
|--------|-------|--------|
| 22 | 20.00 | 100.00 |
| 23 | 60.00 | 140.00 |

## 5.13   Overhead cranes

### 5.13.1  Data

Depending on the selected option "  - observations = coordinates", it is possible to enter the following data:

- **Rail axes**

When editing the data concerning the rail axes, enter: the cross-section number, the current measure (X), the distance of the left rail from the left reference line (a), the span (R), the distance of the right rail from the right reference line (b), the ordinate of the left rail (Hl), the ordinate of the right rail (Hp).

Selecting the option "  - calculations only in horizontal plane", the data concerning only the horizontal plane are edited (without Hl and Hp).

- **Coordinates** – edit the data in the case if the input information are coordinates of the check points. A point number can have up to 12 characters, where a point of the left axis must have the character "L" at the end, and a point of the right axis – the character "P".

### 5.13.2  Calculations

After entering the option   it is possible to specify the degree of the curve into which the rail axes are to be fitted (enabled value y = ax+b means fitting into a curve of the first degree – a straight line).

After pressing the button  , specify the given span – given R. The program will proceed to performing calculations together with writing the coordinates to the working table.
The following calculations are performed in sequence:
1. Initial adjustment, evaluation of measurement accuracy.

2. Fitting the average axes at the optimal R and the given R.
3. Examination of horizontal orientation.
4. Calculation of ground coordinates in the local system and saving the coordinates in the data base.
NOTE !!! In order to perform calculations, at least two full cross-sections are necessary: No., X, a, R, b. Other cross-sections need not contain all data, i.e. a, R, or b can be missing in individual cross-sections. Determination of theoretical axes will be performed on the basis of full cross-sections. Whereas corrections to rectification will be calculated for all cross-sections.

## 5.13.3 Settings

- Fitting the axes for the given R – if "yes" then corrections will be calculated for rectification of the rail axes at the given R
- Fitting the axes for the optimal R – if "yes" then corrections will be calculated for rectification of the rail axes at the optimal R
- Height data:
    - terrain ordinates
    - readout from the staff (in the fields Hl and Hp enter the readout from the staff [mm] – the program will ask for the horizon height for the left and the right rail [mm])
- Rails in 1 horizontal plane – if "yes" then corrections will be calculated according to the highest point for both rails. If "not", the program will ask for the theoretical difference of heights (Hl - Hp))

## 5.13.4 Results

- Initial adjustment – the following elements are printed:
    - coordinates Y of the right reference line for every, full cross-section,
    - sums and coefficients of the reference line,
    - adjusted observations and corrections,
    - adjusted coordinates and M0.
- Corrections to the elevation at the given R:
    - sums and coefficients of reference lines,
    - corrections to rectification of rails at the given span.
- Corrections to the elevation at the optimal R:
    - sums and coefficients of reference lines,
    - corrections to rectification of rails at the optimal span,
    - optimal span.
- Rectification in vertical plane:
    - corrections to levelling of rails.

## 5.13.5 Drawing

After entering this option, two maps are created (HORIZONT_CRANE, VERTIC_CRANE), as well as a form containing graphs of the course of rails and corrections to rectification.
Example:
Enter the data (or load it from the disk from the directory "Examples")

| Ord | Number | Dist. X [m] | a [mm] | R [mm] | b [mm] | H.l [mm] | H.p [mm] |
|-----|--------|-------------|--------|----------|--------|----------|----------|
| 1 | 0 | 1,800 | 0,21 | 15571,00 | 0,20 | 1,11 | 1,10 |
| 2 | 1 | 6,000 | 0,20 | | 0,20 | 1,10 | 1,12 |
| 3 | 2 | 12,000 | 0,20 | | 0,21 | 1,10 | 1,11 |
| 4 | 3 | 18,000 | 0,20 | | 0,20 | 1,12 | 1,10 |
| 5 | 4 | 24,000 | 0,21 | 15570,00 | 0,21 | 1,11 | 1,11 |
| 6 | 5 | 30,000 | 0,02 | | 0,22 | 1,09 | 1,10 |
| 7 | 6 | 36,000 | 0,22 | | 0,21 | 1,08 | 1,08 |
| 8 | 7 | 42,000 | 0,20 | | 0,20 | 1,09 | 1,09 |
| 9 | 8 | 48,000 | 0,21 | 15573,00 | 0,21 | 1,09 | 1,10 |

Icon "Calculate" and specify the given R =15570
Then "Graphs" specify the scales of cross-sections and "OK"

## 5.13.6 Calculation algorithm

**CALCULATION ALGORITHM**
In order to perform calculations, obtain adequate data (presented in the drawing) on the site, using the method of reference lines.
designations:
- $a_i$ – distance of the left rail from the left reference line,
- $b_i$ – distance of the right rail from the right reference line,
- $r_i$ – span of the rails,
- I, II, III, IV – points of the local network.

Calculations can be performed if at least two full cross-sections are measured – this will make it possible to determine the average axes.
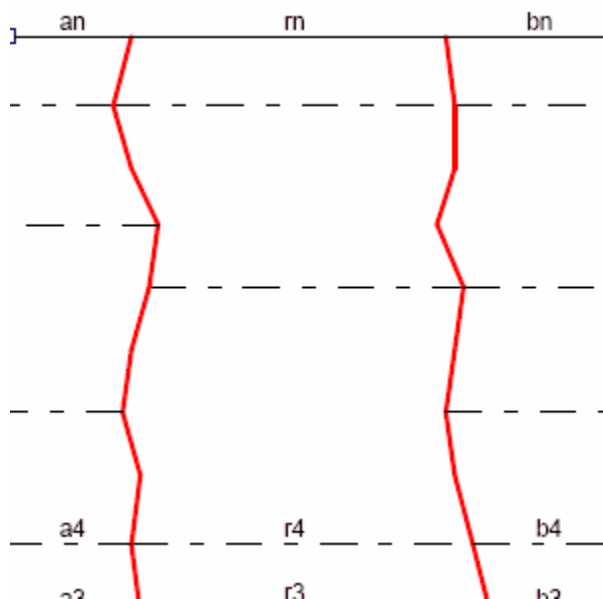


- Adjustment of observations, evaluation of the accuracy of measurements and calculation of rail axis coordinates on the basis of adjusted values.

Adjustment of observations is performed according to the formulas presented below, on the basis of averaged data of full cross-sections, i.e. cross-sections where no., x, a, b, and r are given. At least three full cross-sections are necessary for performing adjustment. On the basis of calculated corrections, accuracy of the performed measurements is evaluated – m0 ® ® 2.5 mm – and rail axis coordinates are calculated on the basis of adjusted values of a, b, r.

$y_i = r + a + b$; $v_i = ®x + ® - y_i$

System of standard equations:
[xx] ® + [x] ® - [xy] = 0; [x] ® + n ® - [y] = 0

Evaluation of the accuracy of measurement: m0 = $\sqrt{\dfrac{[vv]}{n-2}}$

## 5.14   Exact adjustment of horizontal and levelling networks

**Exact adjustment of a horizontal network and a levelling network**
**The module makes it possible to perform exact adjustment of a horizontal network and a levelling network using the method of least squares.**
The maximum number of determined points is 100 (up to 500 points for the Professional version).
The following calculation options are available for a horizontal network and a levelling network:
- *Network control* – checking if the entered data are coherent, calculation of the free terms of correction equations,
- *Network adjustment* – performing calculation of adjusted observations and coordinates (network inspection is performed before adjustment),
- *Evaluation of network layout accuracy* – analysis of the network layout before measurement. Position errors of points and observation errors after adjustment are calculated on the basis of the designed observations (the number zero can be entered in the place of the observation value).
In addition, the following option is available for a levelling network:
- *Dislocations* – the function makes it possible to determine vertical displacements of levelling network points. Successive stages of levelling measurements saved on disk should be loaded as the original measurement and as the current measurement. The program will select the points which are present in both measurements, and will determine their displacements and errors of displacements. The determined values will be included in the report.

For a horizontal network, enter the following:
1) *Coordinates of tie points and approximate coordinates of calculated points*. Enter in sequence: the point number, the coordinate X, Y. If errors of the point position in the direction X and Y are known, they are entered in the column mx and my, respectively. If the error of the point position is known, enter it in the column mp. The points being the tie points are marked by pressing the key <F5> or selecting the option "Tie" from the context menu available after pressing the right mouse button or by

pressing the button:      . Performing one of the mentioned actions results in highlighting the adequate cell in the column "Item".
2) *Angles*. Enter in sequence: point numbers, the value of angle and the error of angle measurement.
3) *Directions*. Enter in sequence: point numbers, the value of direction and the error of direction measurement.
4) *Distances*. Enter in sequence: point numbers, the value of distance and the error of distance measurement. If a zone has been entered (Options -> Calculations -> Zone), then distances reduced to the system 1965 (column D reduced) are calculated in the first step of adjustment.
For a levelling network, enter the following:
1) *Heights of tie points and approximate heights of calculated points* (tie heights are marked analogously as tie points in a horizontal network).
2) *Elevation differences*. Enter in sequence: point numbers, the value of elevation difference and the error of elevation difference measurement. Entering the errors of points and observations can be

performed automatically, using the button:      In the dialog window, enter the value of error and press the button "**Enter current**" or "**Enter all**", depending on whether the errors are to be entered only into the current editor or into all editors.
In addition, the option "**enter only where no error is entered**" can be enabled, which makes the following possible:
- with the option enabled – entering the errors only to these observations which have no value of error entered beforehand,
- with the option disabled – entering the errors to all observations.

Writing the adjustment results (coordinates) into the table is performed after pressing the button

▦ Into table
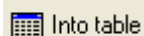
The button [icon] makes it possible to perform the next iteration, i.e. to assign the adjusted coordinates to the approximate coordinates.
It is possible to import a task from polygonal traverses, tacheometry, or from a book of angles and sides. This task must be saved beforehand in the directory of a given project.

∨ | 🕱

Import from polygonal traverse
Import from tacheometry
Import angles and siedes from record book
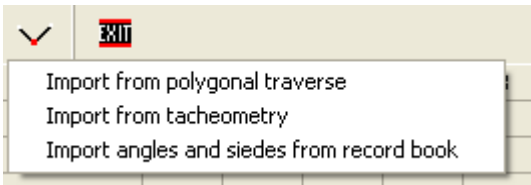
Example:
Adjustment of a horizontal network:
Enter the data.

| Ord | Number | X | Y | mx | my | mp |
|-----|--------|--------|--------|----|----|------|
| 1 | 1 | 100,00 | 100,00 | | | 0,00 |
| 2 | 2 | 200,00 | 100,00 | | | 0,00 |
| 3 | 3 | 200,00 | 200,00 | | | 0,00 |
| 4 | 4 | 100,00 | 200,00 | | | 0,00 |
| 5 | 5 | 150,00 | 150,00 | | | 0,05 |
| 6 | 6 | 0,00 | 100,00 | | | 0,05 |
| 7 | | | | | | |

\Coordinates / Angles /Directions /Distances /Altitude /Elevations /

| Ord | Left | Station | Right | Angle | mk |
|-----|------|---------|-------|----------|--------|
| 1 | 2 | 1 | 4 | 99,9910 | 0,0040 |
| 2 | 3 | 2 | 1 | 100,0030 | 0,0040 |
| 3 | 4 | 3 | 2 | 100,0010 | 0,0040 |
| 4 | 1 | 4 | 3 | 100,0060 | 0,0040 |
| 5 | 4 | 5 | 1 | 99,9950 | 0,0040 |
| 6 | | | | | |

\Coordinates / Angles /Directions /Distances /Altitude /Elevations /

| Ord | Start | End | Dist. D | md |
|-----|-------|-----|---------|------|
| 1 | 1 | 2 | 100,00 | 0,05 |
| 2 | 2 | 3 | 100,11 | 0,05 |
| 3 | 3 | 4 | 99,94 | 0,05 |
| 4 | 4 | 1 | 99,97 | 0,05 |
| 5 | 1 | 5 | 70,70 | 0,05 |
| 6 | 5 | 3 | 70,73 | 0,05 |
| 7 | 5 | 2 | 70,68 | 0,05 |
| 8 | 1 | 6 | 100,03 | 0,05 |
| 9 | | | | |

\Coordinates / Angles /Directions \Distances /Altitude

Then select "horizontal network adjustment" and save the adjusted coordinates in the table.

Adjustment of a levelling network:
Enter the data.

| Ord | Number | H | mH | corr. | H w | mH w |
|---|---|---|---|---|---|---|
| 1 | 10 | 100,51 | 0,01 | | | |
| 2 | 11 | 101,00 | 0,01 | | | |
| 3 | 12 | 101,69 | 0,01 | | | |
| 4 | 13 | 102,01 | 0,01 | | | |
| 5 | 14 | 102,63 | 0,01 | | | |

\Coordinates / Angles /Directions /Distances \Altitude /Elevations /

| Ord | Number S | NumberEK | Dh | mDh | corr. | Dh |
|---|---|---|---|---|---|---|
| 1 | 10 | 11 | 0,50 | 0,01 | | |
| 2 | 11 | 12 | 0,70 | 0,01 | | |
| 3 | 12 | 13 | 0,30 | 0,01 | | |
| 4 | 13 | 14 | 0,60 | 0,01 | | |
| 5 | | | | | | |

\Coordinates / Angles /Directions /Distances /Altitude \Elevations /

Then select "levelling network adjustment" and save the adjusted coordinates in the table.

# 5.15   Calculation of volume, contour lines

This module is used for:
* calculation of the volume of the generated terrain model
* drawing contour lines on the map on the basis of the generated terrain model
* making a vertical cross-section through the terrain model

Sequence of actions:
1. Entering the data
2. Creating the terrain model
3. Performing the calculations of
- volume
- contour lines
- cross-section

## 5.15.1   Entering of data

* Enter the terrain points either by entering manually or by pasting [icon] the coordinates copied beforehand from the working table. Check if all coordinates have height.
* The points constituting the region contour – editing the sequence of points constituting the model boundary.

In the case if coordinates of the points limiting the region of interpolation are not entered, the created model will have the shape of a rectangle spread on the minimum and maximum values of the coordinates X, Y from the set of terrain points. Presented below is a demonstration drawing containing both the data from terrain and a square grid created by the program:
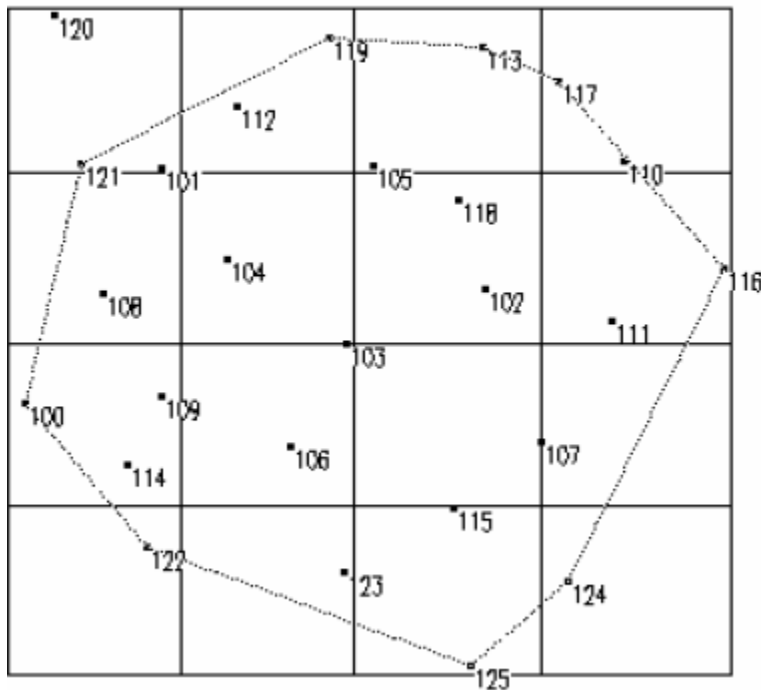
- Cross-section points. A cross-section can run along any broken line determined by the points entered in the tab "Cross-section points". In result of using this option, a task is generated for the module of vertical cross-sections, where further editing of the cross-section is possible by adding a table, descriptions and generating a drawing.
- Constant connections. Used for specifying constant connections between points (skeleton lines, breakline). Characteristic places (slope edge, saddle) can be marked in this way, which influences the shape of the terrain model, increasing its consistence with the actual course in the terrain and giving greater accuracy of volume calculations. This has an application in the case of a terrain model generated using the method of triangles. Constant connections can be entered manually (tab "Constant connections"), pasted from the map (copy the marked points), or after generating a terrain model while editing the triangular grid. Click the icon „insert connection" and indicate the beginning and the end of the connection. A red line will be added on the drawing. Numbers of the points determining this line will appear on the tab "constant connections". The model drawing can be edited by clicking the icon „arrows". By clicking the red line we change it into a normal line (i.e. it will not be a "constant connection" any more), and by clicking the black line we change the quadrilateral diagonal, thus modifying the terrain model. If the model is ready, click "OK".

## 5.15.2 Creating a terrain model

**There are two methods for creating a model**
- On the basis of an entered set of scattered points of regular square grid with calculated heights of nodes . Heights of nodes are calculated as a result of a spline function created on the basis of the measurement points adjacent to a node (the number of points is specified by the user – the value "number of points for spline function" – this method is good for determining the course of contour lines)
- After pressing this icon, a method is available for creating a terrain model using the algorithm of automatic triangulation . Using this method, it is possible to determine very accurately the

volume of regular solids, created e.g. in result of earth works, and thus of any embankments, excavations, i.e. surfaces of sharp declines. For such surfaces, application of e.g. spline functions

resulted in excessive simplifications in the created terrain model. Pressing the ![icon] icon while the

icon ![icon] is pressed results in calculation of the terrain model

Enter in sequence:

- Model name – the name of the resulting set with extension *.nmt.
- Interpolation every ... – the size of the interpolation step (length of the terrain model square side – only for the first method). The lower the value, the more accurate is the created model and the longer it takes to generate the model. For large regions, the model should be interpolated using the method of successive approximations – in the first step a larger interpolation step should be specified (e.g. 50m), after obtaining a result – interpolation errors and observing the interpolation time, it is possible to specify a smaller step, e.g. 5 m, and generate the model again, until a satisfactory result is obtained in a reasonable time.
- Number of points for the spline function – the number of points from the closest surroundings of the grid node taking part in calculation of the spline function (node height); maximum 50. The more points, the more accurate is the model and the longer is the calculation time.
- Truncation to extreme values – "Yes" if the calculated values of nodes cannot be greater (smaller) than the highest (lowest) spot height. Setting "No" is recommended, if characteristic points of the terrain have not been measured.

Calculation of the terrain model can take very long and is dependent on the number of points and the interpolation

The calculated model or spot heights of the terrain can be viewed after pressing the icon ![icon]

### 5.15.3  Calculation of volume

Pressing the ![icon] icon while the icon ![icon] is pressed. Calculations can be performed with reference to a horizontal plane or any plane specified by 3 points. In both cases, the first step is to select the model on which the calculation will be performed from the presented list of existing sets of type "nmt". For calculation of the volume from a horizontal plane, enter the reference level (height of the horizontal plane). For calculation of the volume from any plane, enter the coordinates X, Y, Z of three points determining the reference plane. Value of the surface area of the spatial model and its projection on a horizontal plane are calculated. We recommend the differential method for calculating volumes:

- Generate a terrain model for the lower part of the solid
- Calculate the volume of the model from a given reference level – lower than the existing heights
- Generate a model for the rest of the solid – with the same points limiting the solid as in the first model
- Calculate the volume of the model from the reference level assumed beforehand
- The difference of volumes will give the correct value

The drawing below explains the differential method:
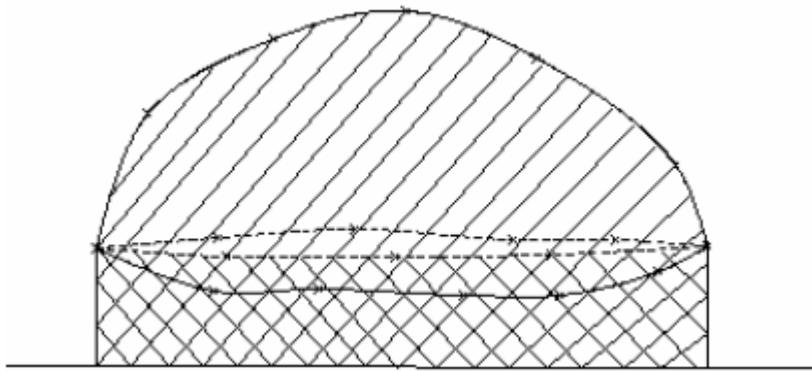
## 5.15.4 Interpolation of contour lines

Pressing the  icon while the icon  is pressed.
In the dialog window, select:

- model – a set of type 'nmt', on which the interpolation will be performed,
- contour interval (for bold, solid, auxiliary and complementary contour lines)
- generalisation coefficient of contour lines (0-40). The higher the coefficient, the lower the number of bend points of a contour line. A low value of the coefficient results in generation of contour lines consisting of a large number of bend points, which makes editing much more difficult and reduces the speed of refreshing the map drawing. After pressing the button "OK.", from the displayed list select the layer on which the contour lines will be placed

## 5.15.5 Cross-section

In order to make a cross-section, enter data into the cross-section points tab

Creating a cross-section begins after pressing the icon  while the icon  is pressed. In the dialog window, enter:

- in the frame "Model" select the name of the model on which the cross-section will be created;
- the task name under which the created cross-section will be saved;
- interpolation interval, i.e. the frequency at which the height will be determined on the cross-section line;
- only maximums and minimums – whether only the local maximums and minimums of the cross-section will be saved, or all points;
- save the cross-section bend points – whether the bend points entered in the tab "Cross-section points" are to be attached to the cross-section; interpolate the heights of bend points, if there are none – if the option "save cross-section bend points" is enabled, determination, if a bend point has no height specified, whether it should be interpolated from the model. After performing calculations, the task will be saved for the module of vertical cross-sections.

## 5.15.6 Example

Example:
Enter the data.

| Lp | Numer | X | Y | H |
|----|-------|--------|--------|---------|
| 1 | 1 | 100,00 | 100,00 | 100,000 |
| 2 | 2 | 120,00 | 100,00 | 102,000 |
| 3 | 3 | 120,00 | 120,00 | 103,000 |
| 4 | 4 | 100,00 | 120,00 | 105,000 |
| 5 | 5 | 120,00 | 140,00 | 102,000 |
| 6 | 6 | 140,00 | 140,00 | 101,000 |
| 7 | 7 | 140,00 | 120,00 | 104,000 |
| 8 | 8 | 140,00 | 100,00 | 101,000 |
| 9 | 9 | 100,00 | 140,00 | 105,000 |

Select the method of creating the model [icon] or [icon]. In the case of the first one, after pressing the [icon] icon specify the model name and the interpolation interval. After creating a model, it can be viewed under the icon [icon].

Clicking the [icon] icon, we proceed to interpolating the contour lines. The icon [icon], select the model, contour interval and OK. Specify the layer on which the contour lines drawing is to be drawn and OK The contour lines are already drawn on the map.

## 5.16  Levelling

**Technical levelling of bench marks with intermediate points.**
In the column 'Number' specify the numbers of bench marks and intermediate points.
In the column 'Distance' it is possible to specify the distances from the station to the target.
In the column 'I' enter the readouts backwards and forwards before the horizon change.
In the column 'II' enter the readouts backwards and forwards after the horizon change.
In the column 'intermediate' enter possible intermediate readouts (e.g. crosspiece).

The button [icon] is used for setting the accuracy of the entered observations (readouts from staffs).
Depending on the setting, it is possible to enter readouts with an accuracy up to 1, 0.1 or 0.01 mm.
In result of levelling calculation on a printout or to a report it is possible to save the value of correction on every station, measured elevation difference and theoretical elevation difference in a traverse, and also a list of elevation differences for every station.

| Ord | Number | Dist. | I | II | interm. I | H |
|---|---|---|---|---|---|---|
| 1 | RpA | | 1652 | 1635 | | 105.803 |
| 2 | 0 | | 1432 | 1415 | | 106.023 |
| 3 | 0 | | 1701 | 1691 | | 106.023 |
| 4 | 1 | | 1423 | 1411 | | 106.303 |
| 5 | I12 | | | | 1616 | 106.098 |
| 6 | p12 | | | | 1657 | 106.057 |
| 7 | 1 | | 1558 | 1549 | | 106.303 |
| 8 | 2 | | 1575 | 1567 | | 106.286 |
| 9 | I13 | | | | 1530 | 106.322 |
| 10 | p13 | | | | 1562 | 106.290 |
| 11 | 2 | | 1804 | 1780 | | 106.286 |
| 12 | 3 | | 1233 | 1210 | | 106.857 |
| 13 | 3 | | 2305 | 2299 | | 106.857 |
| 14 | +50 | | 712 | 707 | | 108.450 |
| 15 | +50 | | 2290 | 2275 | | 108.450 |
| 16 | 4 | | 872 | 857 | | 109.868 |
| 17 | 4 | | 1915 | 1896 | | 109.868 |
| 18 | RpB | | 1401 | 1381 | | 110.383 |

## 5.17   Precise levelling

**Module of precise levelling** makes it possible to calculate the heights of bench marks and intermediate points measured using the method of accurate levelling. Readouts on a staff can be specified in units of centimetres or half-centimetres (ZEISS staffs). The accuracy of readouts is specified from 0.01 mm to 0.0001 mm. The number of measurements can be up to four on one staff (two for the left division and two for the right division). The principle of entering the data is the same as for the technical levelling – i.e. first the readout backwards and forwards to bench marks, and then readouts to intermediate points on the station.

Selection of division on a staff – 1cm or 0.5cm

Specification of the accuracy of readouts on a staff (0.01, 0.001, 0.0001 mm).

Levelling options. Units for displaying the calculated height: m., cm, mm, 0.1mm, 0.01mm. The number of places after the dot in the height – from zero to five. Besides, it is now possible to specify a new height. While entering the data, the module controls the differences between the readouts on the left division and the right division of the staff. The user can specify the value of the upper range and the lower range in which the difference between the left readout and the right readout from the staff must be included – the button [ ! ] in the lower left corner of the levelling window is used for this

purpose.

![icon] The following can be selected for printout: the levelling book itself, the values of corrections to elevation differences, the sum of elevation differences of the traverse, a list of all elevation differences, a list of the calculated heights.

Example:

Enter the data:

| Ord | Number | Dist. | I left | I right | II left | II right | interm. I l. | interm. I r. | pc |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | | 120000 | 726520 | 120080 | 726570 | | | |
| 2 | 11 | | 130010 | 736490 | 140030 | 746500 | | | |
| 3 | 11 | | 500 | 607010 | 810 | 607340 | | | |
| 4 | 12 | | 1500 | 608030 | 2620 | 609100 | | | |
| 5 | 12 | | 23450 | 629990 | 23030 | 629570 | | | |
| 6 | 13 | | 6320 | 612800 | 7550 | 614100 | | | |
| 7 | 100 | | | | | | 13450 | 619960 | |
| 8 | 101 | | | | | | 1660 | 608160 | |

Then enter the heights of bench marks 10 and 13 e.g. 100. The program specifies the traverse closing deviation and results.

## 5.18 Route planning

**Module of route planning** makes it possible to determine the main and intermediate points of a route specified by vertices and parameters of curves.

### 5.18.1 Tab "Route"

Enter in sequence:
- Hectometre – hectometre of the starting point of the route,
- Metre – metre of the starting point of the route,
- Number – number of the bend point of the route axis,
- X – coordinate X of the bend point of the route axis,
- Y – coordinate Y of the bend point of the route axis,
- H – height of the bend point of the route axis (not used for calculations),
- R – radius of the circular arc,
- K1, Ł, K2 – numbers determining the ratio of the length of the first clothoid to the circular arc and the second clothoid, e.g.
- K1 = 1, Ł = 2, K2 = 1 – a curve will be planned, consisting of two clothoids of equal length
- and twice as long circular arc;
- K1 = 1, Ł = 0, K2 = 2 – an asymmetrical biclothoid will be planned (the second clothoid twice as long as the first one),
- Notes – any comment.

Example:

Enter the data of a route consisting of 4 vertices.

On the vertex 1 there is a circular arc of radius R= 150

On the vertex 2 there is a circular arc of radius R= 40 and 2 symmetrical clothoids of length 20 m

On the vertices 3 and 4 there is a circular arc of radius R= 30 and 2 symmetrical clothoids of length 20 m

| Ord | Meter | No | X | Y | H | R | Clo. 1 | Arc | Clo. 2 |
|-----|-------|-----|------------|------------|--------|--------|--------|-----|--------|
| 1 | 0,00 | pocz | 5703393,04 | 3699765,27 | 81,400 | | | | |
| 2 | | w1 | 5703368,05 | 3699771,92 | | 150,00 | | | |
| 3 | | w2 | 5703325,28 | 3699796,24 | | 40,00 | 20,000 | | 20,000 |
| 4 | | w3 | 5703232,55 | 3699757,50 | | 30,00 | 20,000 | | 20,000 |
| 5 | | w4 | 5703199,25 | 3699820,67 | | 30,00 | 20,000 | | 20,000 |
| 6 | | koniec | 5703166,61 | 3699813,12 | 81,150 | | | | |

The icon calculate can be pressed immediately:

And then the drawing:
On the drawing it is visible that the route is running from the north to the south, sequentially through
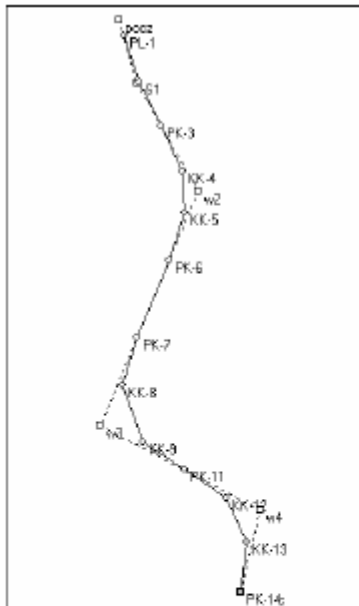
the vertices w1,w2,w3,w4. If we want the program to calculate intermediate points, click the icon and enter „Distance between intermediate points". In this case it is 1 metre. Accuracy of the coordinates XY is assumed. In the same option window, it is also possible to enter whether edges are to be determined along the route. There can be nine edges. In this case the edge no. 1 is away from the route by 5 metres to the right. (The program will double all intermediate points of the route, shifted by 5 m.)
Other options:
- place main points in intermediate points – placing the main points of an arc in the table of intermediate points (in this way the intermediate points and the main points are visible on a route printout).
- Intermediate points at „round" count of hectometres – determination of intermediate points at every hectometre.

- Sequential numbering of the main points within an arc – if this option is not checked, the program is numbering as follows: PL-1,S1,KL-1; PL-2,S2,KL-2; PL.-3,S3,KL-3; whereas if we check the option, the numbering will be: PL- 1,S1,KL-2; PL-3,S2,KL-4; PL-5,S3,KL-6;
- Number of the point on the edge; intermediate; main = hectometre – if any of these positions is checked, then the point number will be the same as its distance from the start of the route. Specify, what should be the accuracy of the given number.
- Accuracy for length data – a possibility to increase the accuracy of the entered lengths of an arc or clothoid – long segments of curves can be influenced by too low accuracy of entered lengths of curves.
- critical angle for fractures – with very small angles of switch of the route tangents, a broken line is planned instead of curves. The user can specify for what angles of switch it is not necessary to enter the arc data.
- Shift of the formation line with respect to the route axis – a change of the parameter results in the formation line being counted as if it was next to the horizontal axis of the route. The offset while determining the heights of points on the edge = given offset + shift. In the tab Renumbering it is possible to specify the method of assigning numbers to straight segments, clothoids or circular arcs, specifying the prefixes and starting numbers, or possibly to specify a uniform numbering for the whole route. After specifying the numbering rules and pressing the button Renumber, the program performs a change of numbering of the calculated points.

### 5.18.2  Tab "Additional points"

It is possible to enter the data of special points on the route of given parameters:
- point at given count of hectometres – by specifying the value of hectometre and metre for the point,
- point beyond the route axis – shifted to the left or to the right (+/-) by the value of shift, e.g. a lantern which has a position determined by specifying the count of hectometres and the distance from the axis,
- point beyond the route axis with the height determined on the basis of a given decline and distance from the axis, e.g. a trench bottom. However, in this case it is mandatory to enter the height parameters of the route in the tab Vertical arcs, described below.

### 5.18.3  Tab "Vertical arcs"

After specifying the route parameters: the coordinates XYH of the route vertices and the radii of vertical arcs (at the places where vertical arcs are to occur), the heights of the intermediate points and the additional points of the route are determined.

| Ord | Hect. | Meter | No | X | Y | H | R | Meas. hect. |
|-----|-------|-------|------|------------|------------|-------|---|-------------|
| 1 | 0 | 0,00 | PT | 6052403,00 | 3617728,09 | 29,37 | | 0,00 |
| 2 | 0 | 57,00 | | | | 29,91 | | 57,00 |
| 3 | 1 | 3,00 | | | | 30,37 | | 103,00 |
| 4 | 1 | 48,00 | | | | 30,50 | | 148,00 |
| 5 | 1 | 65,00 | | | | 30,53 | | 165,00 |
| 6 | 1 | 81,50 | | | | 30,60 | | 181,50 |
| 7 | 2 | 10,00 | | | | 30,66 | | 210,00 |
| 8 | 2 | 27,00 | | | | 30,62 | | 227,00 |
| 9 | 2 | 60,00 | | | | 30,46 | | 260,00 |
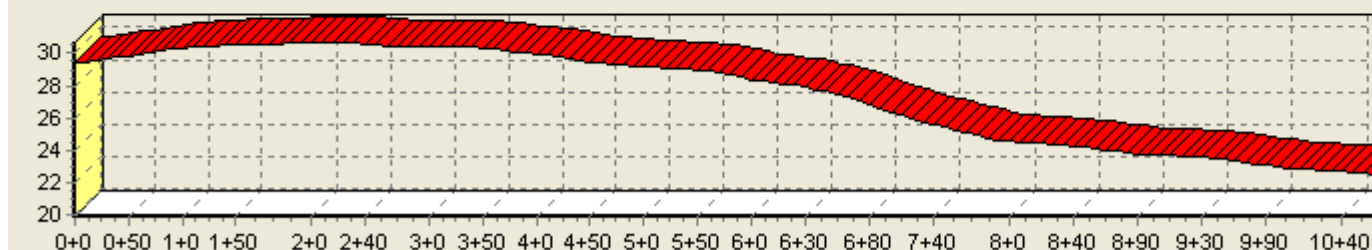
Path / Main points / Intermediate points / Additional points / Vertical Arcs / Edge / XY -> hect. / Controled points /

After determining the height of the route points and performing the calculation, it is possible to see the course of the route in a vertical cross-section – the graph in the lower part of the route planning window. On the drawing it is visible that the point sd1 is the beginning of an arc, sd2 is the center (radius 400m), and sd 3 is the end of the arc. Analogously, successive points.

After pressing the icon: a preview of the whole route is available as a 3D model, in the form of an animation. In addition, the route axis can be sent to the module of vertical cross-sections as a task –

longitudinal route cross-section – by pressing the icon:

## 5.18.4 Tab "Edge"

In this tab it is possible to calculate an edge similar to the one described above, except that this edge need not be parallel to the route axis on the whole length and it is possible to specify the declines and vertical shifts. Enter the points that will determine the edge by entering hectometre, metre, shift from the route axis, decline, shift H (for calculated points).

| | |
|---|---|
| Select / unselect | F5 |
| Unselect all | |
| Select all | |
| Insert "Przes." for all | |
| Insert "Slope" to all | |
| Insert "Dev. H" to all | |
| Insert "Deviat." to selected ones | |
| Insert "Slope" to selected ones | |
| Inser "Dev. H" to selected ones | |

⬆ Options     Prefix before calculati
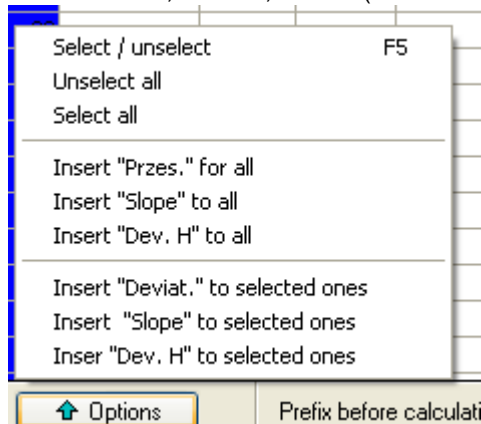
In order to insert additional equal horizontal shift for all entered points.
In order to insert additional equal vertical shift for all entered points.

Prefix before calculating points numbers: `k`   This prefix will be added in front of the calculated numbers of the edge coordinates.

<span style="color:magenta">Example:</span>
Create an edge, entering data as in the table. Enter in sequence hectometre and metre of a point,

horizontal shift and vertical shift. Then click calculate: 💡 and the icon ▦ save the edge points to the working table.

| Ord. | Hect. | Meter | Shift | Down% | Shift. H |
|------|-------|-------|-------|-------|----------|
| 1 | 0 | 1,00 | 10,00 | | 1,0000 |
| 2 | 0 | 2,00 | 10,00 | | 1,0000 |
| 3 | 0 | 3,00 | 10,00 | | 1,0000 |
| 4 | 0 | 4,00 | 10,00 | | 1,0000 |
| 5 | 0 | 5,00 | 10,00 | | 1,0000 |
| 6 | 0 | 6,00 | 10,00 | | 1,0000 |
| 7 | 0 | 7,00 | 10,00 | | 1,0000 |
| 8 | 1 | 1,00 | 10,00 | | 1,0000 |
| 9 | 1 | 2,00 | 10,00 | | 1,0000 |

## 5.18.5  Tab " X,Y -> hect."

In this table it is possible to enter the coordinates of points and after pressing the icon calculate: 💡 the program will calculate, at which hectometre of the route the point is located, and its shift from the route axis

## 5.18.6  Tab "Control points"

In this tab we can check what is the difference between the designed data of the road and the measured data.
For this purpose, enter the designed data of the road in the upper table.
Left hect., left metre and left decline – these specify the left edge of the designed road. It is likewise with the right side. In the lower table, enter the numbers and coordinates of the measured points – check points on the edges and the axis of the route. These coordinates can also be obtained by

clicking : 📄 Import GSI   Import points from Leica.GSI

## 5.18.7  Layer name

 Here enter the layer name. It will be visible in the report (if saving to a report will be performed).

## 5.18.8  Layer execution tolerance

Lower value of deviation and upper value of deviation
– the deviations in a report which exceed the given values will be marked with the character „#"

➡ Eksport txt   Export of the result file to a text set (after calculations).
➖ Clear points   Removal of survey points (from the lower table).
📊 Cross-section   Shows graphically the difference between theoretical and practical course of the route.

After pressing the icon calculate:  the program performs calculations of main points and intermediate points of the route and other tabs – provided that they are filled (these points can be browsed after changing the tab). The calculated points can be written in the working table after

pressing the icon  . On the printout it is possible to place the following information: main points of the route, vertices of the route, intermediate points, additional points, parameters of curves, vertical

arcs. The icon:  is used for selecting this information.

The icon  makes it possible to place the route drawing on the map.

# 5.19   Vertical cross-sections

**The module enables to generate a drawing of cross-sections on the basis of numerical data**.

Data can be entered from keyboard; marked points can be pasted  from the table of coordinates;

or imported  from a text file. Besides, it is possible to move the already entered points between different layers of one cross-section task or between cross-section tasks, for this purpose use the option Copy/Paste available under the right mouse button while editing cross-sections. Maximum 15 cross-sections-layers can be placed on one drawing (the Standard version enables to create two cross-sections). The data for individual cross-sections are entered in successive tabs entitled I-XV.

Depending on the setting of the buttons  the coordinates X, Y, H or distances and heights are entered. In the latter case, specify whether adjacent distances (between successive points on the cross-section) or cumulated distances (accumulating from the first point) will be entered. For each point of a cross-section it is possible to add 5 rows of additional description whose content can be entered by the user (columns "Description 1", " Description 2", " Description 3", " Description 4", " Description 5" in cross-section points editors). In addition, it is possible to place a description located on a reference to a point (column "Description on cross-section").

 - calculate – calculations are performed (bend angles, declines, etc.) without a cross-sections drawing

 - performing calculations together with generation of a drawing.

 - Settings:

 **Settings**
- setting the units in which the distances, heights and declines are entered and calculated.
- Specifying, what type of distances between points are entered to a cross-section: adjacent, cumulated (accumulating from the first point), or from hectometres (accumulating from every hectometre).
- Stabilisation of the height of the description letters in the table below the cross-section, the cross-section title
- What to edit, i.e. which ones of the additional columns are to be editable
- Enabling the printing of a millimetre grid overlaid on the cross-section, automatic generation of a cross-section print form. It is also possible to disable editing of some layers of the data column.

**Calculations –** calculation of the area contained above the second and below the first cross-section (excavation), and above the first and below the second cross-section (embankment)
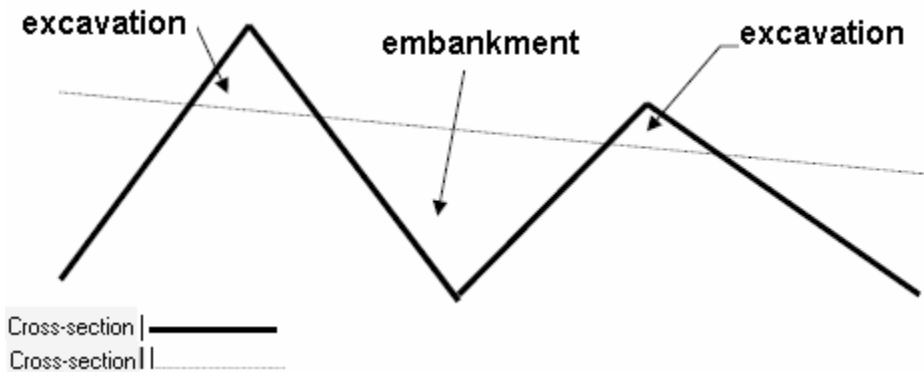
**Increments –** shifting the cross-section by a given value of height or distance. The shift can concern any layer of the cross-section.

## 5.19.1  Tab "Parameters"

This tab makes it possible to specify:
- the number and content of the rows located in the table below the cross-section.
- comparative levels.
- colors of individual layers of cross-sections.

The mentioned parameters can be set for each of 15 cross-sections, using the panel located in the lower part of the window.
- Column "Row" – enter a value specifying the row in which the description is to be placed. Value of "0" means no row in the table below the cross-section.
- Column "H of letters" – font size (in mm) in the row.
- Column "Angle" – the angle in degrees, at which the description is made (value of 90o means drawing the descriptions vertically).
- Column "Center" – specifies whether a given description is to be placed near the reference or between references (option enabled).
- Column "H of rows" – specifies the height of the row in which cross-section descriptions are placed. (If the value is „0", the program accommodates the row height automatically)
- Column "Point no." – enter the number of the point on which the comparative level is to be defined. For one cross-section it is possible to enter several comparative levels, changing on the cross-section points.
- „Comparative level" – specify the height of the comparative level on the point

Besides, it is possible to specify whether the cross-section title is to be placed on the drawing, whether the additional description is to be placed vertically on references to the cross-section points, the
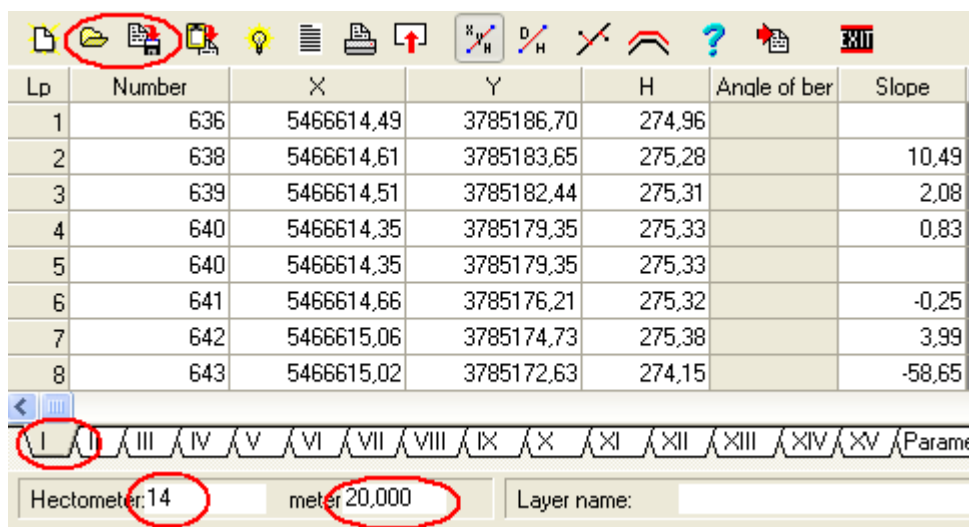
following buttons are used for this: 

## 5.19.2  Tab "Volume"

This tab makes it possible to calculate the volume between selected layers of cross-sections on a given segment. For this purpose, save cross-section tasks, specifying the values of hectometres. After entering the tab „Volumes", specify the starting and ending hectometre and the numbers of the layers between which the volume will be calculated. After performing calculations, a report will be generated, containing the value of calculated volume. On the below drawing, the data of a cross-section have been entered – two layers (tabs I and II, of which the first one is currently visible) which include here the data before and after milling the road surface.

These can be coordinates (as in the example) as well as distances and heights. In order to calculate volume from cross-sections, it is necessary to describe the location of the cross-section on the route – to specify its count of hectometres – e.g. 1420th metre of the route, i.e. 14th hectometre and 20th metre. After entering these data in appropriate fields, it is important to click with mouse in another field on the screen, because only then the hectometre or metre data will be remembered by the program. After saving a task to disk and pressing the icon of loading tasks, we should see the count of hectometres for every task:
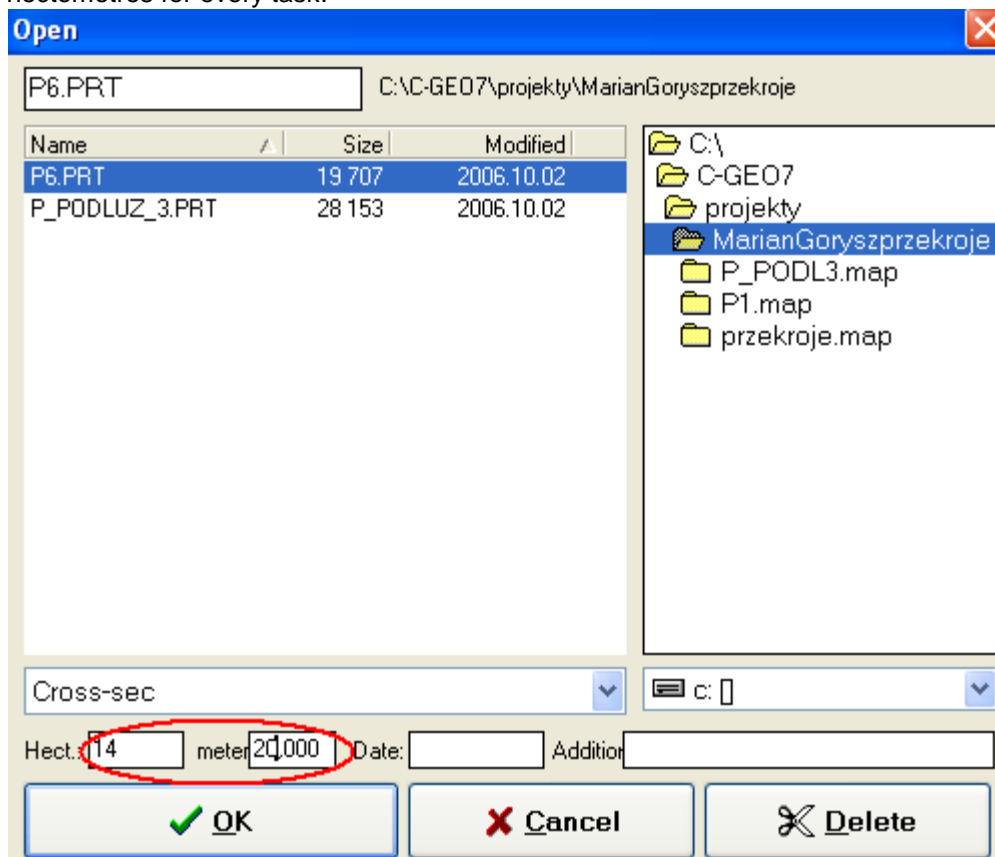


If all cross-sections on a given segment of the route have already been entered and saved, it is possible to proceed to calculating the volume. For this purpose, select the tab **Volumes** in the module

Vertical cross-sections. Here specify the starting and ending count of hectometres (broken into hectometres and metres) – it is important that the tasks created beforehand be contained within the given limits. Next, specify between which layers the volume will be calculated, (e.g. between the first one and the second one, as in the attached example tasks). The last option is the selection, which one of the selected layers will be treated as the top layer.

After pressing the icon **Calculate**, successive tasks are loaded and calculations are performed. In result, a table as above is visible.

### 5.19.3  Tab "Export/Report"

This tab makes it possible to export the generated cross-sections to a text file. The user can specify which cross-sections are to be exported (specifying the starting and ending hectometre), which layers will be exported, and what additional information is to be included in the text file. Generating a report or printout on a cross-sections data printer looks exactly the same.
Example:
Enter the data.

| Lp | Number | X | Y | H |
|----|--------|------|------|------|
| 1 | 1 | 5559632,86 | 3810066,50 | 190,788 |
| 2 | 2 | 5559633,05 | 3810065,10 | 190,546 |
| 3 | 3 | 5559633,24 | 3810063,64 | 191,089 |
| 4 | 4 | 5559633,57 | 3810062,59 | 191,202 |
| 5 | 5 | 5559634,05 | 3810059,21 | 191,262 |
| 6 | 6 | 5559634,79 | 3810055,77 | 191,191 |
| 7 | 7 | 5559635,07 | 3810054,96 | 191,154 |
| 8 | 8 | 5559635,37 | 3810053,44 | 190,572 |
| 9 | 9 | 5559635,45 | 3810052,08 | 190,878 |

Then in the tab PARAMETERS:

| Descr. | Row | Char H. | Angle | Centr | Row H | | Point No | Comparat. level |
|--------|-----|---------|-------|-------|-------|--|----------|-----------------|
| Terrain points | 1 | 1,8 | 0 | ☐ | 0,0 | | 1 | 189,000 |
| Terrain ordinates | 2 | 1,8 | 0 | ☐ | 0,0 | | | |
| Distances in terrain | 3 | 1,8 | 90 | ☐ | 0,0 | | | |
| Terrain slope | 4 | 1,8 | 0 | ☒ | 0,0 | | | |

entering such parameters will result in the table below the cross-section drawing looking as follows:



| P.p. 189.000 | | | |
|--------------|------|--------|------|
| Terrain points | 1 | 2 | 3 |
| Terrain ordinates [m] | 190.788 | 190.546 | 191 |
| Distances in terrain [m] | 0.00 | 1.41 | 2.89 |
| Terrain slope [%] | | −17.129 | 36.881 |

Click the icon ⬆ . Specify the cross-section scale and OK. The program creates a form and a cross-section map.

## 5.20 Book of angles and sides

**The module calculates:**

- angle and angular deviation from measured directions in two positions of the telescope,
- reduced lengths and elevation differences from measured vertical angles and spatial distances.
- angles on the basis of directions measured in maximum three series. The book of angles can be generated in tacheometry from tacheometric stations in which the observations to distances have been marked as ties. Averaged values of angles, angular deviations and average distances (if they are entered) are obtained in result of the calculation. Observations are entered in the form of a book of angles and a book of side measurements. ⌄ "extracting" observations from tacheometric stations. If tacheometric stations are saved in the project, a task containing the observations at tie points can be created for the book of angles and sides.

Example:

A tacheometric station saved in a selected project as a task in tacheometry

After pressing ⌄ a window appears, in which a list of all stations in the given project is displayed. Using the button ">" – one or ">>" – all, we select the stations from which the observations are to be extracted.

After pressing the button <OK>, a task of a name specified by the user is created.

After executing the option "load task", observations are displayed in the book.

# Part VI

# 6    OPTIONS

## 6.1    Program parameters

### 6.1.1    Tab "Map"

1.  Program installation adds to the operating system a special vector font called C-GEO  - this font will be set as the default font in the program. C-GEO font was created to enable plotting on ink plotters as well as marker plotters, it also enables double underlines and other functions.The default inscription font is used in import functions and when entering any text on the map.
2. Inscription width (% of height) - conventional character width
3. Font  used in forms descriptions
4. Point description font size:

- on screen - set point description size in the map options  ■11
- on printout - set point description size on a printout

5. Text inclination - text inclination angle for *Italics* function
6. Default map scale displayed in "Create map" option
7. Codes set - choose a mode used for codes entering in coordinates table and calculation modules
8. Show/hide map menu toolbar
9. Warn me before removing objects - will display a confirmation window before deleting an object
10. Rescale lines - turn on/off lines calibration option while resizing the map view
11. Line thickness set by color - use this option to print all lines with this same (thinnest) thickness (irrespective of lines thickness on the map). Option enables to set line thickness by color for marker plotters.
12. Rotate all inscriptions (irrespective of "to network - to frame" attribute setting)
13. Select only one element of object - enable/disable a selection  of all object elements created by

the   K1  tool on the map.
14. Sound signals on the map - the program plays different sounds in different situations like: entering a point in "open air" or snapping to point etc.
15. Map background - set map background color.
16. Monitor diagonal - use this option when you draw a line (when "Rescale lines" option is  switched off) to see lines on the screen in exact same dimensions as in the definition.
17. Raster color - set in what color rasters are displayed
18. Square grid and reference lines thickness - set line thickness for those two map elements.
19. Description color same as point color - enable this option to use point color for description text.

**Raster printing method -** raster reduction value from 0-10 (from lowest reduction to highest). Option is useful on big map surfaces when  vectors and rasters need to be combined. Lowered quality of a raster image effects in faster data transmission to the printer.

**Mouse roller** - Set zooming coefficient for mouse roller (1,2 - 3.0) and select if to zoom in centrally or
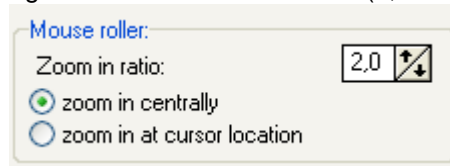


at mouse cursor location.

## 6.1.2    Tab "Calculations"

1. Units - set angular units and area units  used in the calculation modules.
2. Accuracy - set accuracy (number of places after the decimal point) used to display different values
3. Projection - set projection zone of 65 and 2000 systems
4. Altitude over sea level - mean altitude over sea level used to reduce surveyed distances
5. Confirm when raport is saved - enable/disable displaying the confirmation window
6. Save points without numbers. Those points will be drawn only on the map  (will not appear in the table)
7. Round off coordinates - calculated points are saved in the table with full accuracy - with many places after the decimal point. Enabling the round off option will eliminate in further calculations all decimal digits which appear after the set accuracy point.
8. Warn before saving if such task already exists - displays a confirmation window before overwriting a file.
9. Red. 65, 2000 and over sea level when calculating distances from coordinates - optional reduction from 65, 2000 systems and on the sea level when calculating distances from coordinates in modules:
- Orthogonal, projection
- Polar, setting out
- Azimuths, lengths, angles
10. Select a formula for the calculation of maximum linear deviations
11. Enable displaying the question if to save a raport after the calculations are performed

## 6.1.3    Tab "Other"

1. Coefficient of printer calibration - entered values are used to multiply  transfer of coordinates data  to the printer. Test different settings to find coefficient values that fit your device best - the program can store up to 5 coefficient sets under specific names.
2. Font size in editors - set the size of font used in the tables.
3. Save workplace - enable/disable saving the workplace (opened windows layout) when closing the program. When this option is activated the program will always restart with same windows layout as it was before closing.
4. Print black & white - enable/disable printing in color.
5. Autonumbering - enable/disable points autonumbering (e.g. in the tables)
6. No page protruding - disable sending FF (Form feed) sign when printing of a report page is completed.
7. Open map window automatically - opens the map window simultaneously with table windows.
8. Choose language version.
9. Check available space on the disk - checks free disk space every time the program starts. If there is not enough space available the program will display a message and close down. Then clear your disk and restart the program.
10. Company name - text which will be printed when "Print company name" function is activated.
11. Line thickness coefficients - it is possible to rescale lines thickness displayed on the screen and printed by a printer (plotter). Assign a coefficient to each line thickness, the thickness of printed lines will be multiplied by entered coefficient. This option is useful if your printing device changes lines thickness defined in the program.
12. Login window - enable/disable displaying C-Geo login window.

### 6.1.4 Tab "Transmission parameters"

Set the parameters of data transfer through RS232 port. For most transmissions from recorders it is only required to set the port number, the program will set other parameters automatically depending on the type of selected recorder. Also you may set the parameters of connected digitizer (read the digitizer manual for details) and a delay of coordinates transmission to the recorder.

## 6.2 Report parameters

Use this option to set different parameters of reports in particular:
- header, footer - set what information should be printed in header/footer also if those information should be printed only on the first page of a report or all pages. You may place any content in both header and footer - graphic (company logo), description fields (KERG, TERYT etc.)
- in the margins section set top, bottom, left and right margins (in centimeters)



## 6.3 Editor of symbols

**The editor makes it possible to create or modify symbols existing in the program**. The symbols are displayed on a grid with 1mm spaces between its lines. Right side of the window shows drawn symbol in different scales. To switch between scales click on appropriate view. A unique number is associated with every symbol, this number is shown in "Number" field. New symbol may be defined under any unused number higher than zero and smaller than 1000.

Use the buttons  ,  to switch between the existing symbols.
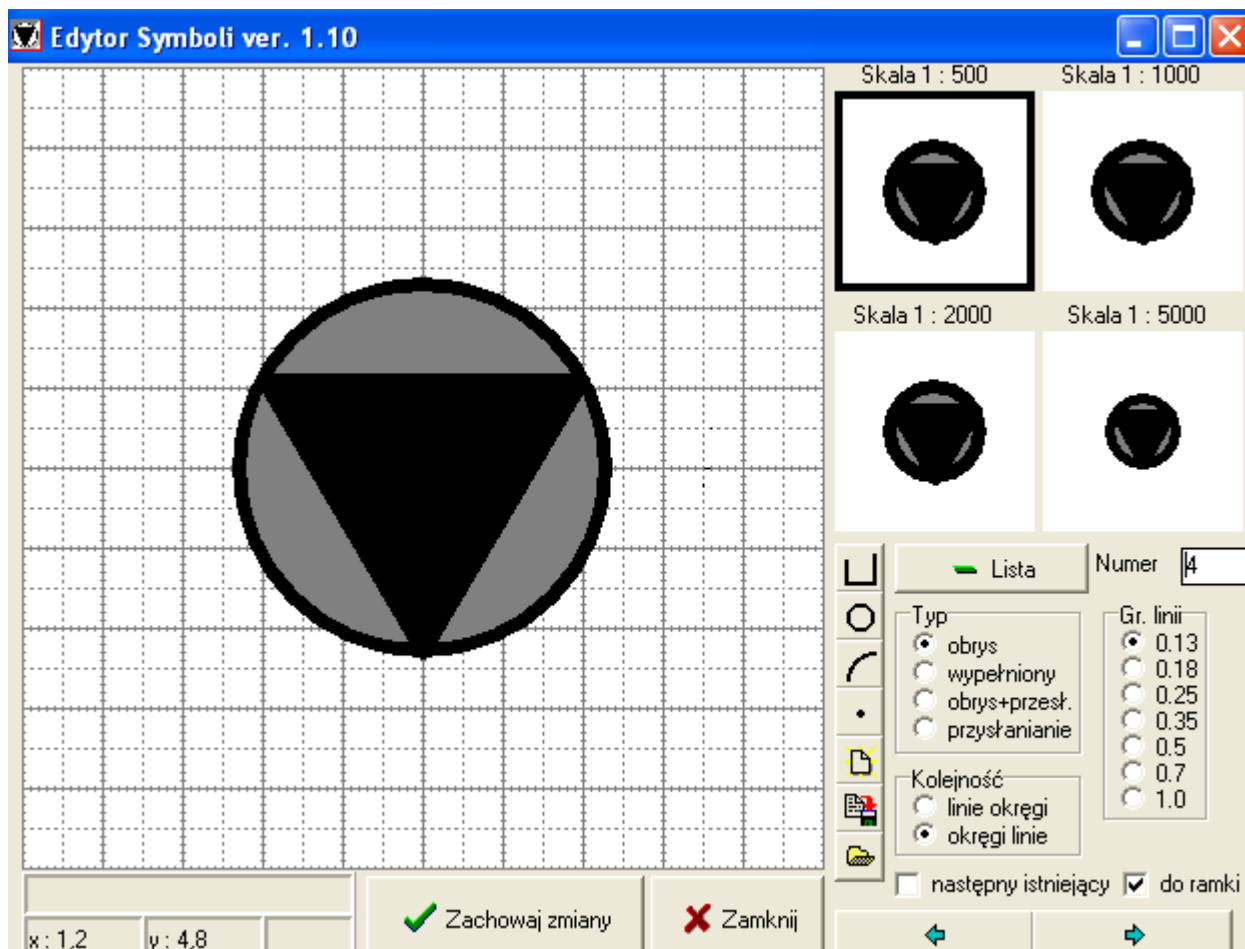
**Available options:**

 - draw a broken line. Use the left mouse button to indicate the bend points. Finish drawing by pressing on the right mouse button.

 - draw a circle. Indicate the center point and a radius.

 - draw an arc. Indicate three points: initial point, endpoint and any point between them.

 - indicate the place of symbol insertion (red dot)

 - clear symbol

 - save symbol

 - load symbol

The button "List" shows all elements that the symbol consists of, here you may also remove unnecessary elements.
The frame "Type" determines how constituent elements of the symbols are drawn:

- contour - draws outline only,

- filling - draws outline and filling,
- cont+overlay - draws outlines with "transparent" filling that overlays the map content
- overlay - draws only overlay areas

The frame "Sequence" determines the drawing order of constituent elements of symbols.
All entered changes will be saved on the disk only when the button "Save changes" is pressed.
Pressing the button "Close"  will cancel all entered changes. If you have defined a new symbol and pressed the button "Save changes" then restart C-Geo program, select the option "Window->Codes" click on "fill out blank fields" and then  OK. Now double-click on the last column of newly created code, a window "Choose symbol" will show up - here find the symbol you have defined (value displayed in the frame "Number" corresponds to the number from the "Editor of symbols")

## 6.4    Toolbars

In "Options - toolbars" you may select which of the toolbars will be displayed in the map window. Also you may modify the toolbars and place them in any region of the map window or on its edges.
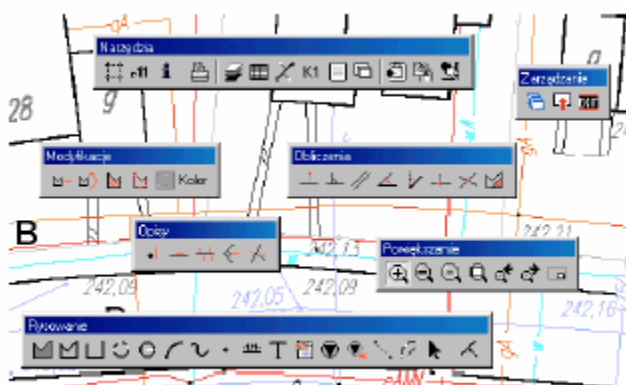


## 6.5    Editor of forms

**The editor makes it possible to create a form or modify forms existing in the program.**

Available options in the editor of forms:

- load form to the editor;

- save form;

- determine size of sheet;

- move form on the screen;

- zoom in - by clicking or selecting a region (when the left mouse button is pressed)

- zoom out;

- show all;

- select tool;

- insert line. After selecting this tool click the left mouse button to indicate the initial point of the line and when the left mouse button is pressed stretch the line to its endpoint. Double-click displays a dialogue window, where it is possible to set the parameters of drawn lines.

- insert text field. After selecting this tool indicate with the mouse left top corner of the text field (the left mouse button pressed) and set its size. Double-click on this button displays a dialogue window "Inscriptions parameters" where you may define the parameters of entered text.

- work field. Define a work field - an area in which the map will be drawn. Indicate with the mouse cursor left top corner of the work field, press the left mouse button and while this button is pressed move the mouse cursor to the place of right bottom corner.

All elements of the form have their equivalents in the text file displayed in the left part of the editor of forms window. Changes in the form may be done by editing its graphical part as well as by modifying the text section.

# 6.6  Codes

The K1 set of codes included in the program is a combination of codes included in the K1 instruction and codes developed for the needs of Geo-Info v. 2.6. The difference in the amount of codes in both sets results in:

- codes without their equivalents remain not changed when they complete a code set e.g. when changing from Geo-Info code set to K1 the code SOPB1 (Horizontal network I classified in the instruction as B-III) will be added to the list of codes K1
- if few codes have one equivalent it will be assign to them as many times as it appeared in the previous set. Although it has same designation the program will distinguish it in such a way that another change of the set of codes will assign codes properly.

Use the option of the main menu "WINDOW->CODES" to display the list of codes. The columns contain as follows: symbolic code, numerical code, group (for which the code is assigned), object description (taken from Geo-Info program) and symbol (if defined). Double-click on the "Symbol" column opens a window with definition of all symbols where it is possible to assign a symbol to a code. Use the Editor of symbols to create new symbols.

Buttons meaning:

- find code <Crtl S>. Depending on the highlighted column enter: code in symbolic mode, code in numerical mode or a string of characters from object name.

- sort codes. Sort by highlighted column.

- print table of codes

- add new code

- remove code

- transfer code to the table <Crtl P>. This option is available only when the list of codes was opened from the context menu (available in the table after pressing the right mouse button). In this situation header of the window with the list of codes contains an information e.g. "Table of codes. Instruction K-1. Connection with the table..". Selected code will be transferred to an active row in the table.

**EXIT** - close window

Context menu (available by pressing the right mouse button on the list of codes):
1. Delete row (Crtl K) - remove code from the list

2. Transfer to table <Crtl P> - same function as under the button
3. Transfer selected <Crtl Z> - same as point no. 2 but selected code will be entered to all selected points in the table.

# Part VII

# 7    REPORTS

## 7.1    Manager of reports

**The option "Reports"** makes it possible to browse and print previously saved reports (icon [icon] ) with calculations results.

The window "Reports" contains two sections. Upper part contains a Manager of reports (a list of available reports), with task names and dates of saving. Lower part of the window contains an Editor of reports (a preview of highlighted task).

**Manager of reports**

 - remove selected report

 - remove selected reports

 - filter reports. It is possible to filter reports by given calculation.

Selection of "Cross-section" will effect in displaying all reports concerning cross-sections.

  Reports may be sorted by name (alphabetically), by date of creation or report or table for which the report was created. Order defined by the user - any order set with use of the "Move data" buttons.

  Select / unselect reports - single reports or all reports

 - save current selection. This option enables to save the selection of tasks.

## 7.2 Editor of reports

The editor of reports is similar to editors like WORD or WORDPAD. The picture below shows the first page of a report. The user may view all pages, rescale the view and edit the content. Other available tools enable to create tables, insert drawings, set text alignment, serach the document, set font style and paragraphs. Print preview is available before printing.

## 7.3 Report in TXT format

This is a simple editor used for edition and printout of textual reports.
Icons meaning:

 - new document

 - load document

 - save document

 - print document

 - printer settings

 - undo - last performed operation

 - redo - last performed operation

 - cut - removes selected fragment

 - copy - copy selected fragment to the clipboard

 - paste - paste text from the clipboard

Other elements from the toolbar enable to set margins, font size and page length (number of rows).

## 7.4 Activation of modules

If you  decide to buy one of the additional modules:
- exact adjustment
- volumes and contour lines
- raster vectorisation
- route planning
- vertical cross-sections

please contact us. If a module was ordered with the program then activation is not necessary. If a module was not bought with the program you must update it by entering in the activation window an activation code which will be sent to you.

## 7.5    On-line updates

Program updates are available on-line. If your computer is connected to the Internet click the "Update" button.(Start-Programs-CGeo-Update) If your computer is not connected with the Internet you may update C-Geo with the use of a downloaded file. First download the update file from our  website on any other computer which is connected to the Internet, then copy the file to the folder C:\C-GEO (you must overwrite older version of this file that already exists in this folder).

# Part VIII

# 8    PLUG-INS

Support for external files *.exe, *.ink, *.bat* (so-called plug-ins). If a subfolder "wtyczki" containing some program files (extension *.exe, *.ink, *.bat*) is present in the directory in which the program is installed, then a menu "Plug-ins" with a list of programs will be added at the start-up of C-Geo. Every program from this menu is called with 3 parameters: the path of the current project, the name of the current working table and the name of the active map/base window (provided that any window of this type is active).

# Part

# IX

# 9 EXAMPLE OF CALCULATION COURSE

In the case of any doubts while working in the program, it is recommended to use the HELP in the main program menu or to press the key F1.

1. Begin the work by creating a project and a table. In the main program menu select the option FILE, and then PROJECTS. In the opened projects window, in the frame Projects press the button

![Add new project] , enter the project name: e.g. TEST, and press ENTER or click the button [OK],

then in order to create the table press the button ![Add new table] ; enter the table name: DATA, and

confirm with ENTER key. Mark the table as the working table using the button ![Set as working type] (in

order to write the calculated coordinates in it) and press the ![Open table] button.
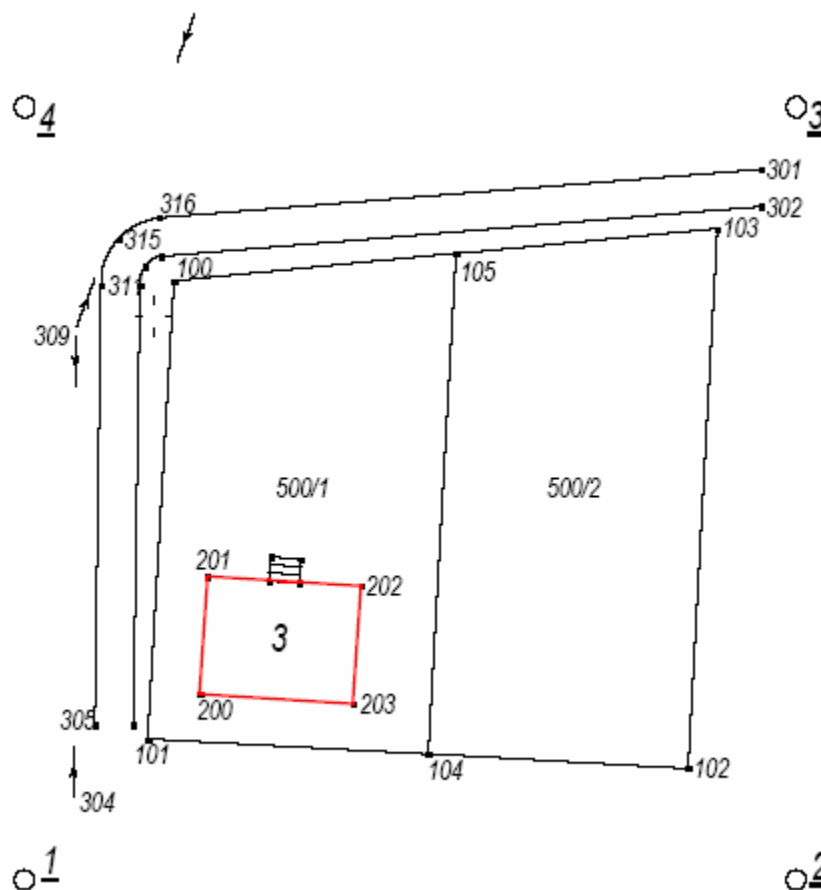


2. In the opened table, enter two given points of the network: the first one of coordinates x=100, y=100 and the second one of coordinates x=100, y=200. Let us assume that they will be points of a detailed horizontal network of class III. Therefore it is possible to enter their codes (OSP) immediately.

3. Two points drawn with an appropriate symbol are visible in the middle of the map field. If the

symbols are not visible, magnify the given area by clicking the icon {![MAGNIFICATION icon] MAGNIFICATION} (the mouse cursor will change into a magnifying glass symbol) and select the interesting fragment in one of the two possible ways:

- by clicking with mouse on the region we are interested in
- marking a region with a frame by holding the left mouse button

For drawing clarity, it is possible to enable the description preview, clicking the icon { POINTS DESCRIPTION}. The description preview is disabled by default. Click the inscription ENABLED (it is also possible to set the size and select the values to be displayed). NOTE! The description preview will only be displayed on the screen.

If we want the description to be printed on a printer, enable DESCRIPTION AS TEXT, set the font, the style and the position. Click [OK].

4. Our network will consist of four points. We will calculate the remaining two points using the option CALCULATIONS -> POLYGONAL TRAVERSE. In the upper table, specify the tie points numbers: In the frame TIE P1 enter "1" and ENTER, and in TIE P2 – "2" (the code and the coordinates will be copied automatically from the working table). This is a closed traverse, therefore we do not specify the ties K1 and K2.

In the lower table, enter in sequence the number of the second tie point "2", the angle and the distance to the third point of the traverse. (angle "100"; distance "100"). In the row Item 2 enter the number of

the next point of the traverse "3", its code (after clicking the icon { EDIT POINTS CODES}), angle and distance. The network in the example has square shape, therefore the angle=100, and the distance=100. In the next row Item 3 enter the number "4", the code "OSP", the angle "100", the distance "100". In order to terminate the traverse, in row Item 4 enter "1" and the angle "100". If

everything was filled correctly, then after pressing the icon { CALCULATE} the calculated coordinates of the points 3 and 4 should appear, with a message saying that this is a closed traverse and specifying the error values. Now it is possible to save the report, clicking the appropriate icon, as

well as to save the task. After exiting the module { EXIT}, click { REFRESH} in the map window.

5. Next, we want to calculate the coordinates of the bend points of the parcel boundary, and to execute its division. The coordinates of the points 101 and 102 will be calculated using the polar method, and the coordinates of the points 100 and 103 – using the orthogonal method. Go to the option CALCULATIONS->POLAR and enter the data of the tie points. The station "1", the tie "2" and the direction e.g."147.1240". Go to the option POINTS DATA and enter in sequence the number "101", the

direction "93.1820" and the distance "24.23". Next, press the icon { PERFORM CALCULATIONS} or press the keys <Ctrl O>. The coordinates of the point 101 should be: x=118.16; y=116.04. Go back

to TIE DATA, click the icon { NEW DATA} and enter the data of the tie points. The station "2", the tie "1" and the direction "220.3460". Go to POINTS DATA and enter in sequence: the number "102",

the direction "271.1340", the distance "20.14". Press the icon: { PERFORM CALCULATIONS}. The

result: x=114.42 y=185.94; press { EXIT} and { REFRESH} in the map window. Go to the option CALCULATIONS->ORTHOGONAL, enter the data of the tie points "3" and "4". Go to the option POINTS DATA and enter in sequence the number "103", the current "10.31", the offset "-15.69", and in

the second row the number "100", the current "80.78", the offset "-22.52". Press the icon: { PERFORM CALCULATIONS}. The result: 103; x=184.31; y=189.69;

100; x=177.48; y=119.22; { EXIT, REFRESH}.

6. In order to create a layer of parcels, click the icon { LAYERS}, [ADD LAYER] and specify the name, e.g. "PARCELS". Next, set the layer type to PARCELS (the check box "Layer type"). A descriptive base for parcels will now be automatically created. In order to proceed to editing this layer, double-click the word NOT in the column EDITABLE. Then click [CLOSE].

7. Create the first closed object. It will be a parcel of number 500.
Bend points: 100, 101, 102, 103. This can be performed in one of the three ways:

- { CLOSED OBJECT} – clicking sequentially on the points on the map. In order to close the parcel, indicate the last point the same as the first point or before closing press the right mouse button and select the option: TERMINATE.

- {  OBJECTS EDITOR} – entering sequential numbers of points (100,101,102,103,100)
- { OBJECTS K1} – quickly creating objects on the map in accordance with the instruction K1

Select the tool {  CLOSED OBJECT} (the mouse cursor has changed to a cross). Click the successive points 100, 101, 102, 103. Then click with the right mouse button. A context menu appears:
- terminate (closes the object to the starting point)
- terminate perpendicularly (this option is useful if the object is e.g. a square or a rectangle and we have its three points)
- terminate to frontages (determination of the last point from a linear intersection)
- next point (in this way it is possible to create an object, having its two first points and determining the successive points from frontages)

Select TERMINATE, the object has been created. Click the icon {  SELECTING} in order to change the cursor back to the arrow symbol. In order to enter the parcel number, press the icon {  INFORMATION} and click the parcel field with the arrow. The parcel has been highlighted and a table has appeared. Enter "500" and ENTER (It is possible to determine the surface area by clicking the icon {  CALCULATE SURFACE AREA}). Click {  MOVE TO MAP} (the highlight should be located in the column "Parcel_number" of the window DATA), set the parameters and [OK]. The parcel number should appear in the centre of the parcel. Let us assume that we want to enter one more column into the descriptive base: SURNAME. Click {  STRUCTURE} and [ADD FIELD]. Enter "SURNAME"
- TYPE: (what will be entered in the edited field. In our case, a text type field – surname)
- Text (for text data)
- Integer (for integer numbers)
- Real (for real numbers. E.g. the field AREA is of this type)
- Date (entering a date)
- OLE object (makes it possible to enter an OLE type object)

Set the field width, e.g. "20", the function OTHER and [OK]. Now, marking with mouse the field SURNAME for the parcel no. 500, it is possible to enter e.g. "Smith".
8. In order to perform a division of a parcel, the parcel must be selected with mouse (the parcel area will be painted) and click with the right mouse button. A context menu appears:
- Information (basic data about the object)
- Set editable (results in setting the layer with the selected object in our case -PARCELS- as editable, without the need to go to the icon {  LAYERS}. It is possible to edit only one layer at any given moment. See HELP->C-Geo HELP->FIND->LAYERS).
- Edit (editing the object with the possibility to enter the measured frontages, calculate the area and adjust it).
- Remove (removes the object).
- Move to (makes it possible to move the object to another layer).
- Frontages (makes it possible to insert frontages on the map for the given object).
- Fill object (stairs, slopes, retaining wall) – makes it possible to fill the object with an appropriate symbol.
- Object division. (we select this option)

We want to divide our parcel in half, and the division line is to be parallel to the line 100, 101. Click with mouse the table field NUMBER and enter "100" ENTER "101" ENTER.
Next, click the field DESIGNED AREA and enter "2264.5". Next, click the field NUMBER in the lower table and enter the numbers of the new points "104" and "105"; Click [OK]. The object on the map (the parcel no. 500) has been divided. The numbers of the new parcels 500/1 and 500/2 are entered as described in point no. 8. Now delete the old parcel number from the map (click it and press the key DELETE)
9. The next task is to determine a building on the parcel 500/1, where the terrain data are two measured points of the building and frontage measures. Create a buildings layer, clicking the icon {

LAYERS}, [ADD LAYER], and enter the name, e.g. "BUILDINGS". Set the layer type to BUILDINGS, mark it as EDITABLE and click [CLOSE]. Go to the option CALCULATIONS->ORTHOGONAL and enter the data of the tie points "1" and "4". Go to the option POINTS DATA and enter:
the number "200", the current "24.00", the offset "22.64"
in the second row:
the number "201", the current "39.24", the offset "23.64".
Press the button { PERFORM CALCULATIONS}.
The result:
200; x=124.00; y=122.64;
201; x=139.24; y=123.64.

Press: { EXIT and REFRESH in the map window}.

Click the icon { CLOSED OBJECT}. Click the point no. 200, and then 201 (a line should be drawn between them). Next, click with the right mouse button and from the context menu select: NEXT POINT TO THE RIGHT. In the table NEXT POINT click with mouse NUMBER and enter "202", click LENGTH and specify the frontage "20.00" ENTER. Click again with the right mouse button and select TERMINATE PERPENDICULARLY. Enter the no. "203" (also remove the default code OSP) and ENTER. The building corners are on the zero layer (they have no codes), and the building contour in

on the layer BUILDINGS. Click { SELECTING}, { REFRESH}.
In order to enter the building number, proceed as in the case of a parcel (point 8)

10. In order to determine stairs, click the icon { LAYERS}, set ZERO LAYER as editable and

[CLOSE] (the stairs cannot be placed on the buildings layer). Select the icon { CALCULATIONS}. In the opened table, select the option ORTHOGONAL CALCULATIONS. Click on the map in sequence on the point 201 and 202 (their numbers and coordinates should appear in the table). In the table below them specify the number of the point on the straight line "201a", the current "8.00", the offset "0"

and the icon { CALCULATE}. In the table field calculated point specify the number "201b", the

current "12.00", the offset "0" and the icon { CALCULATE}, { CLOSE WINDOW}. Two points of the stairs are already on the map. Click { CLOSED OBJECT} and connect analogously as with a building: 201a, 201b, the right button NEXT POINT TO THE LEFT no. "201c" the distance "3" [OK], the right button TERMINATE PERPENDICULARLY – no."201d" [OK]. In order to draw the stairs, mark this object (clicking it with the arrow symbol), click with the right mouse button and select FILL OBJECT - STAIRS. Next, in the dialog window select the number, the interval and the shift of the stairs. In order

to have the stairs drawing not covering the building contour, go to { LAYERS}, click the layer BUILDINGS and with the button on the right side of the table move the buildings layer above the zero layer (because the stairs drawing is on this layer). It is possible to do likewise e.g. in the case of contour lines.
11. Next we will determine other features. Given are terrain measurements performed using the orthogonal method. The measured features are: one lantern, three power network poles, two trees and a sidewalk.
Go to the option CALCULATIONS-> ORTHOGONAL, enter the data of the tie points "3" and "4". Go to the option POINTS DATA and enter:

| Lp | N | | Distance | Offset | Uwagi |
|---|---|---|---|---|---|
| 1 | 301 | | 4.66 | 7.98 | chodnik |
| 2 | 302 | | 4.66 | 12.91 | chodnik |
| 3 | 303 | SLU | 77.18 | 14.23 | słup sieci niskiego napięcia |

(The symbol code can be entered now or while editing the point on the map).

Press the icon { CALCULATE}. Go back to TIE DATA, click the icon { NEW DATA} and enter

the data of the tie points "1" and "4". Go to POINTS DATA and enter:

| | Nเ | เ __ | Distance | Offset | เ __ฺ |
|---|---|---|---|---|---|
| 1 | 304 | SLU | 9.92 | 6.32 | słup sieci niskiego napięcia |
| 2 | 305 | | 19.97 | 9.00 | chodnik |
| 3 | 306 | | 19.97 | 13.99 | chodnik |
| 4 | 307 | | 26.95 | 18.83 | drzewo |
| 5 | 308 | | 34.93 | 20.00 | drzewo |
| 6 | 309 | SLU | 70.99 | 6.59 | słup sieci niskiego napięcia |
| 7 | 310 | LAT | 72.85 | 16.70 | latarnia |
| 8 | 311 | | 76.89 | 10.00 | chodnik |
| 9 | 312 | | 76.89 | 14.89 | chodnik |
| 10 | 313 | | 79.36 | 15.56 | chodnik |
| 11 | 314 | | 80.70 | 17.57 | chodnik |
| 12 | 315 | | 82.94 | 12.20 | chodnik |
| 13 | 316 | | 85.63 | 17.46 | chodnik |

The icon { CALCULATE}, { CLOSE WINDOW}, { REFRESH}.
The codes LAT and SLU have been placed on ZERO LAYER. These codes can be moved to other layers using the option MAP->CODES<->LAYERS. The points 307 and 308 are deciduous trees. The symbols can be assigned using one of the two ways:
• Point 307
Click the icon { OBJECTS K1}, look for LAND DEVELOPMENT
and MEASURED DECIDUOUS TREE or enter in the frame "DLI", click SYMBOLS and now we have a

tree symbol glued to the mouse cursor. Click the point 307 and { SELECTING}. Close the window K1. By selecting the option MAP->CODES<->LAYERS we can see that the layer LAND DEVELOPMENT has been created automatically, and the tree code DLI has been assigned to it.
• Point 308

Click the icon { SYMBOLS}, from the list LAND DEVELOPMENT select the symbol MEASURED DECIDUOUS TREE, select the layer and [OK].
Next, click the point 308 with the tree symbol glued to the mouse cursor.

The icon { SELECTING}. Next we will draw the sidewalk. Select editable ZERO LAYER in {

LAYERS}, LINE STYLE - SOLID LINE [OK] [CLOSE]. { OPEN OBJECT} and connect the points

305-311 and TERMINATE (the right mouse button), 306-312, 302-314, 301-316. Select { ARC} and connect 312-314 and click 313, connect 311-316 and click 315.
The points 304, 309 and 303 are low voltage power network poles. Click the icon { OBJECTS K1}, look for POWER NETWORK, LOW VOLTAGE OVERHEAD LINE or enter in the frame "PNN", click OPEN OBJECT and connect the points 304-309-303 and TERMINATE (the right mouse button). Now the layer POWER NETWORK has been automatically created.

12. Levelling
The network points have been levelled in the terrain by using the technical levelling. Let us assume that the point no. 100 has the height of 100.00 m. The measurement results are entered to the table in the option CALCULATIONS -> LEVELLING. In the first row, enter in sequence:
The number of the point backwards "1", the readout backwards from the first and the second measurement.
Underneath:
The number of the point forwards "2", the readout forwards from the first and the second measurement, etc. The table will look as follows:

| Numer | Odl. | I | II | pośr. | H |
|---|---|---|---|---|---|
| 1 | | 1254 | 864 | | |
| 2 | | 3953 | 3562 | | |
| 2 | | 3872 | 3912 | | |
| 3 | | 325 | 365 | | |
| 3 | | 2134 | 1735 | | |
| 4 | | 1801 | 1400 | | |
| 4 | | 1698 | 1832 | | |
| 1 | | 2877 | 3009 | | |

Click the icon { CALCULATE} and specify the height of the point no. 1 "100.00"

Click [OK] on the message about the calculated deviation (-4.50 mm) and { EXIT}.
The heights: 1=100.00; 2=97.300; 3=100.846; 4=101.179

13. The network points already have their heights. Lets try to interpolate contour lines between those points.
Before performing this operation it is recommended to cerate a new layer CONTOUR LINES.  Click

the icon { LAYERS}, {ADD LAYER}, enter text "LAYERS" then press [OK] (for better clarity of the map content it is possible to change colors - double-click the left mouse button on LINE TYPE/COLOR) and [CLOSE]. Go to the option CALCULATIONS -> CALCULATION OF VOLUMES, CONTOUR LINES. Enter in sequence network points numbers "1", "2", "3", "4". On the tab POINTS CREATING AREA CONTOUR enter points which bound the interpolation area. Enter in sequence "1",

"2", "3", "4". Next click the icon { CALCULATE}, enter the name of created project and length of sides in the square grid model. The program will perform calculations and display model parameters.

Click on the icon { CONTOUR LINES} and again the icon  { CALCULATE}. Enter which contour lines are to be drawn and press [OK]. Click on the layer CONTOUR LINES then [OK]. After the calculations in the map window the contour lines will be drawn (this example shows that the contour of a building overlays the contour lines drawing, it happens because the layer BUILDINGS is located on higher position in the layers hierarchy).

14. Now lets perform a manual interpolation. With use of the tacheometry method 15 points from the station no. 4 were measured with directional tie on point no. 3.  Go to the option CALCULATIONS->TACHEOMETRY. Measured were differences in elevations Dh and spatial

distances so click the appropriate icons ( , ). Enter station "4", height of teh instrument "1,78". Next enter spot heights data

Click the icon  { CALCULATE}. Values of the deviations will be displayed. Exit this module and in {

 LAYERS} set the CONTOUR LINES layer as editable. In order to create a contour line manually

first determine skeleton lines. Click the icon { CONTOUR LINES}, click on the points 1002 and 1005. Between those points a dot should appear (it is a point located on the contour line with height of 104 meters). Use similar way to connect points 1004-1003, 1010-1009 and 1012-1013. Again click the

icon { CONTOUR LINES} and connect points of height 104 meters. Use similar way with other contour lines.

15. The last calculation point in this course will be to transform our coordinates onto the system 65. Go to the option FILE->PROJECTS zna create a new working table table (e.g. DATA1). Set the table DATA  as the PRIMARY TABLE. Now data for calculations will be taken from the primary table whilst the calculation results will be saved in the working table. Open the PRIMARY TABLE.

| Nr | Odl. prz. | Kierunek | Dh | Hc |
|---|---|---|---|---|
| 3 | | 100.0000 | | |
| 1000 | 29.40 | 52.5400 | 0.120 | 1.700 |
| 1001 | 48.94 | 37.1735 | 1.320 | |
| 1002 | 86.53 | 17.8633 | 3.421 | |
| 1003 | 75..05 | 39.8315 | 2.321 | |
| 1004 | 99.46 | 36.1498 | 3.925 | |
| 1005 | 70.41 | 16.5893 | 2.320 | |
| 1006 | 68.22 | 39.1520 | 2.120 | |
| 1007 | 54.90 | 79.5424 | 1.020 | |
| 1008 | 88.19 | 86.7157 | 1.020 | |
| 1009 | 90.45 | 69.4476 | 2.320 | |
| 1010 | 107.14 | 59.3567 | 3.520 | |
| 1011 | 123.80 | 51.8149 | 4.320 | |
| 1012 | 142.54 | 62.7487 | 4.021 | |
| 1013 | 125.76 | 73.8988 | 2.320 | |
| 1014 | 111.18 | 88.2757 | 0.720 | |
| 1015 | 114.10 | 80.1466 | 1.420 | |

Select all points in this table excluding the points 1,2,3 (adjustment points). The easiest way to do it is

to click on {SELECT ALL} then use the F5 key to unselect points 1,2,3. Next click on the icon {
COPY}. Enter the option CALCULATIONS-TRANSFORM and enter the coordinates of adjustment points:

| Lp | Numer | Xp | Yp | Numer | Xw | Yw |
|---|---|---|---|---|---|---|
| 1 | 1 | 100.00 | 100.00 | 1w | 5492100.00 | 3752100.00 |
| 2 | 2 | 100.00 | 200.00 | 2w | 5492100.00 | 3752200.00 |
| 3 | 3 | 200.00 | 200.00 | 3w | 5492200.00 | 3752200.00 |

Now go to the tab TRANSFORMATION POINTS and click the icon { PASTE}. Enter points

numbers for the secondary system: 4w, 100w, 101w etc. Click the icon { CALCULATE}. When the working table is opened go to DATA->TABLE WINDOW->DATA1 to see the effect of the transformation.

# Part X

# 10   ACCESSKEYS IN C-GEO

**Accesskeys in the MAP window**

Set as editable                 **Ctrl + Q**
Exclusiveness mode          **Ctrl + W**
Selection mode                 **Ctrl + K**
Draw closed object           **Ctrl + Alt + Z**
Draw polyline                   **Ctrl + Alt + O**
Draw curve (spline)          **Ctrl + Alt + S**
Insert text                        **Ctrl + Alt + T**
Arrow, selection               **Ctrl + Alt + W**
Editor of objects              **Ctrl + E**
Print                                **Ctrl + P**
Raster - old window          **Ctrl + R**
Change scale                   **Ctrl + S**
Find point on the map        **F2**
Presentation mode            **F12**

**Accesskeys in the TABLE window**
What to edit                     **Ctrl + E**
Change code                    **Ctrl + P**
Search in column              **Ctrl + S**
Show hidden points           **Ctrl + Alt + P**
Hide selected points         **Ctrl + Alt + B**
Hide @ points                   **Ctrl + Alt + M**
Delete line                       **Ctrl + K**
Delete selected lines        **Ctrl + Del**
(also deletes inscriptions in the side window TEXT)
List of codes                    **Ctrl + L**

**Selecting**
Select points                    **F5**
Invert selection               **F6**
Unselect all points           **F7**
Unselect @ points            **F8**

**Working with the table**
Left, right, up, down          **keyboard arrows**
Scroll up                         **Page Up**
Scroll down                      **Page Down**
Beginning of table            **Ctrl + Home**
End of table                      **Ctrl + End**
Beginning of row              **Home**
Delete field                      **End**

**General accesskeys**
Data                                **Ctrl + T**
GEO files manager           **Ctrl + G**
Calculator                        **F10**
Switch on the map            **Ctrl + M**
Close current window        **Ctrl + F4**
Switch between

opened windows        **Ctrl + F6**